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Measurements of operational efficiency in the outpatient setting

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MEASUREMENTS OF OPERATIONAL EFFICIENCY IN THE OUTPATIENT SETTING

by

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JUDY GROOMS BURN. Measurements of Operational Efficiency in the Outpatient Setting. (Under the direction of M. CLINTON MILLER, III.)

The results of patient flow, work sampling, and demographic analyses of the General Medicine Outpatient Clinic at the Medical University of South Carolina are presented. Data collection procedures are discussed. The association between clinic efficiency and selected demographic characteristics of the patient population is examined. Inhibitors to smooth patient flow are revealed through the examination of the distributions of service and queue times. Hourly distributions of staff time expended in various activities are presented, and the work sampling data is correlated with results from the patient flow study. The usefulness of the results as indices of clinic efficiency is considered.

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Chapter I

INTRODUCTION AND BACKGROUND

Rationale

"The criteria most needed in the field of medical care today - aside from accurate measurements of its quality - are sensitive, objective, quantified measurements of the efficiency with which medical care is given" [8]. This statement was made by R. B. Fetter and J. D. Thompson more than ten years ago. Yet, measurements of operational efficiency are still needed today in the planning of new and restructuring of existing systems responsible for health care delivery. And, perhaps no where is this need greater than in the area of outpatient medicine.

The role of the outpatient clinic in the delivery of health care has increased significantly in recent years. Due to rising operational costs and a shortage of hospital beds, many illnesses which formerly required hospitalization are now being treated on an ambulatory basis [9]. Thus, with the number of clinic visits ever growing, it is imperative that a facility be operating smoothly and efficiently. Patient satisfaction is an important objective to be considered in providing high quality medical care [6], and operational efficiency is necessary to insure that the patient's time is not wasted on unnecessary waiting.

A second reason for needing measurements of efficiency is that the structure of the ambulatory system has become increasingly complicated. Medical advancements have provided the system with a seemingly endless

array of services, all of which aid in diagnosing and treating the patient. Each of these services, however, usually requires its own specially trained staff, in addition to separate facilities within a clinic. Such sophistication demands the efficient organization of these services in order to fully utilize the abilities of the highly trained professionals and to obtain the most benefits of such services.

Finally, efficient operation of the clinic system is especially desired if the clinic is a university-based one. This type of facility functions not only as a deliverer of health care, but also as a source of education and training to medical students, physicians, nurses and other professionals. In order to handle the health care needs of its patients and still promote the most valuable learning experiences for its students, the operation of the university-based outpatient clinic must be organized efficiently.

Much of the research into operational efficiency in the ambulatory setting has been based on time parameters. While useful in themselves in the process of planning change, the parameters are in the statistical sense dependent variables and thus have analytic value. Through a thorough investigation of the conditions and factors in the clinic influencing these parameters, results may be obtained providing new information on clinic operation, insight into casual processes and data confirming or rejecting explanatory hypotheses [11].

Measurements of operational efficiency in the outpatient setting utilizing time parameters can be accomplished through the techniques of patient flow and work sampling analyses. More specifically, these techniques are employed to record in detail the timed activities of both patients and staff. The objectives of a patient

flow analysis in an outpatient clinic are: 1) to describe the flow of patients through the clinic; 2) to determine those factors influencing the movement of a patient through the clinic; and 3) to examine the level of clinic operation by patient load. A work sampling analysis provides: 1) a description of the staffing patterns in the clinic; 2) quantitative information delineating various activities in which the clinic staff are involved; 3) a measure of the level of staff utilization; and 4) an assessment of the interdependence of staff functions.

Although not a direct measurement of efficiency, information on selected characteristics of the patient population is useful in the investigation of all factors influencing clinic operation. Thus, for the purpose of determining the influence, if any, of the population served on the rate of patient flow, a demographic analysis can be conducted in conjunction with the patient flow and work sampling analyses.

The purpose of this paper is to report the results of patient flow, work sampling and demographic analyses of the General Medicine Outpatient Clinic at the Medical University of South Carolina.

Literature Review

Most studies of operational efficiency in the ambulatory setting have been based on measurements of the patients' waiting times, and attempts to reduce these times through various methods. Much of the recent work in this area originated in England, where the hospital outpatient department, as part of the National Health Service, provides speciality consultation and treatment. Since this service is funded

and managed by the government, operational efficiency and patient acceptability have been a major concern to the National Health Service. Thus, this agency's interest, as well as publications by the Nuffield Provincial Hospitals Trust calling attention to the public's indignation at long waiting times, have prompted considerable investigation into these matters [8].

Welch and Bailey [17] stated in 1952 that there is a close relationship between the length of the patients' waiting time and the total idle time of doctors in the clinic. While it was common practice to overinsure against the physicians being kept waiting at the expense of the patients, Welch and Bailey argued that "the consultant's time is not infinitely valuable, and in practice some kind of a balance must be struck between doctor and patient." Suggestions were made for the design of an appointment system, emphasizing that physicians must be punctual for the start of their clinics and that patients cannot be called faster than they can be seen. Investigation of the problem was accomplished by Bailey using queuing theory and hand simulation of a clinic. He examined the influence on waiting times of varying the number of patients present at the start of clinic and changing the length of the appointment interval relative to the mean consultation time. It was recommended that patients be given appointments at an interval equal to the average consultation time of the doctor, and sessions start with two patients present.

White and Pike [18] in 1964 also considered the use of a properly designed appointment system to balance the waiting times of both doctors and patients. Like Bailey's model, their simulation model tested factors of clinic size, number of patients present at the start of clinic, and

variable consultation times on the length of physician and patient waiting times. In addition, however, White and Pike examined the efficiency of various appointment schemes with both punctual and unpunctual patients, and found that the waiting times of the two groups did not differ greatly. They concluded that even with unpunctual patients, an appointment system could be effectively designed to balance the waiting times of physicians and patients.

In the United States studies have emphasized the value of simulation in improving efficiency through the examination of waiting times. The relationship between physician idle time and patient waiting time was again considered in 1966, this time by Fetter and Thompson [8]. After a thorough survey of literature on the subject and reviewing three specific waiting time studies, Fetter and Thompson determined that the waiting-idle time relationship was influenced by at least seven variables: appointment interval, service time, patients' arrival patterns, number of no-shows, number of walk-ins, physicians' arrival patterns and interruptions in patient services. A hospital outpatient simulator was designed, and the effects of the variables on the waiting-idle times was investigated under various conditions. While showing the importance of efficiency review in ambulatory care facility, the results of the simulation studies also demonstrated that a model useful to the design and operation of such facilities could be successfully designed.

In 1968 Johnson and Rosenfeld [11] analyzed the data collected in a patient flow study of eight New York City ambulatory care facilities. Results revealed that a wide variation in the length of patients' waiting time existed among the eight institutions. Using waiting time as a measure of clinic organization and management, Johnson and Rosenfeld

reasoned that the wide variation in times indicated unevenness in service. Further analyses revealed that two factors in the clinic operation were primarily responsible for these differences. By reducing the time interval between patients' and physicians' arrivals and by changing from a block to an individual or semi-block appointment system, waiting times were significantly improved.

Before reviewing the literature in the area of work sampling analysis, a brief discussion of the development and history of work sampling is in order.

A technique of work measurement characterized by qualitative, intermittent, and instantaneous observations over an extended period of time, work sampling originated in industrial management [1,4]. In the 1880's, what workers do on the job was researched by Frederick W. Taylor using continuous time studies where timed observations of activities are made continuously by an observer "shadowing" the worker. In 1935 the British statistician L. H. C. Tippett, applying statistical theory to management problems, found that taking randomly spaced observations of workers provided the same information as that obtained from the continuous time studies, but with less trouble and expense. Called "ratio delay", this method was further developed by R. L. Morrow, who applied it to the problem of finding the proportion of a worker's time spent on delays [1].

In the early 1950's, work sampling was being used in many areas where it was once thought to be impossible to obtain measurements of work activity. The Division of Nursing Resources of the United States Public Health Service issued a manual in 1954 encouraging the development of methods to study the activities of nursing and other unit

personnel [3]. That same year, a study using the work sampling technique was conducted by the Division of Nursing Resources in a New York hospital to determine the effect on the nursing staff's activities of assigning a floor manager to the unit. An important discovery concerning the work sampling technique evolved from the study. Contrary to industrial engineering practice, unbiased observations of personnel could be made using regularly, rather than randomly, spaced intervals [1].

The industrial engineers believed that in using regularly spaced observations, workers could anticipate the appearance of an observer and thus would change their normal work routine. Furthermore, the activities of some personnel occur in a fixed time pattern, and observations made at regular intervals may give an erroneous impression of their performance. Proponents of the fixed interval method argued that observer bias was negligible. The personnel, involved in the busy activity of a hospital floor, forgot about the observers after their initial appearance, and then did not deviate from their normal work routine. Also, it was argued that hospital work was not like work on an assembly line. The activities of the personnel did not follow a fixed or repetitive time frame, but occurred more or less randomly [1]. Thus, the work sampling technique had evolved from the expensive and complicated continuous studies of the industrial setting to a method which, now relatively easy to administer, could be applied to the medical field.

In a paper which has since become a classic in the area of applying work sampling to medical professionals, Abdellah and Levine [1] in 1954 reported the results of a reappraisal study using the fixed length work sampling method. The study was designed to inform the administrators of three Michigan hospitals whether they faced a nursing shortage, and

if improper assignment of duties was contributing to the shortage. Additional studies [5,16,20] made in the 1950's utilized the work sampling method to determine the various activities in which nursing personnel were involved.

In 1961 R. J. Connor [3] used work sampling to obtain quantitative measurements of the factors influencing the work load of nursing personnel. Employing a more analytic approach than previously seen in the literature, Connor investigated the relationships among various indicators of clinic operation and the activities of the nursing personnel through regression analysis. Results of the analysis demonstrated the value of work sampling in not only providing information on how time is spent, but also in giving insight into the conditions under which the study was conducted. It is this latter aspect of the work sampling technique which is important to the process of evaluating operational efficiency.

In 1967 a systems analysis of The Johns Hopkins Comprehensive Child Care Clinic was undertaken. Funded by a grant from the Children's Bureau of the United States Department of Health, Education and Welfare, the project was a joint effort of The Johns Hopkins University School of Medicine and the Westinghouse Electric Corporation. One of the products of the study was a Clinic Self-Evaluation Manual for the Determination and Improvement of Clinic Efficiency [15]. Step by step, the procedures for conducting a clinic self-evaluation are presented and thoroughly discussed. Insights into clinic functions are gained through the techniques of patient flow, work sampling and information analyses. Successful applications of the manual have been documented in the literature [7,10].

Studies were initiated in 1974 at the Medical University of South Carolina (MUSC) to obtain measurements through patient flow, work sampling and demographic analyses of how efficiently the MUSC Outpatients departments were delivering health care. Preliminary review of the outpatient facilities had indicated that increased patient loads were straining the operation of the clinics. Concern was expressed that inefficient operation could endanger the effectiveness of the clinics in teaching ambulatory care and possibly diminish the quality of care being given [19].

The Pediatrics Outpatient Clinic was the first clinic to be investigated under the project. Results from the analyses clearly showed the value of such simple techniques for measuring the efficiency of the staff and operational procedures of any given clinic [19]. In addition, the results demonstrated a definite need for methods to improve efficiency utilizing the available resources of that clinic. Thus, the need for measures of operational efficiency having been established, additional studies were undertaken in the General Medicine, Renal-Hypertensive and Endocrine-Metabolic Clinics.

Objectives

The specific aims of this study were to:

1) describe the patient population of the General Medicine Clinic in terms of demographic and socio-economic characteristics;
2) measure and describe the patient flow through examination of patient arrival patterns, mean queue and service times and frequency distributions of queue and service times;

3) investigate the influence of the demographic characteristics of the patient population on the flow of patients through the clinic;
4) measure and describe the work effort of the clinic staff;
5) examine the relationships between the flow of patients and the work effort of the clinic staff.

Chapter II

METHODS AND PROCEDURES

Nature of the Clinic

The General Medicine Outpatient Clinic studied was an afternoon clinic which met five days a week, Monday through Friday. The clinic opened with patient registration, usually at 12:30 p.m., and lasted until approximately 5:00 p.m.. General Medicine personnel included four members of house staff, two registered nurses, two licensed practical nurses, and one secretary-clerk. In addition, the Supervisor of Clinic Nurses, a registered nurse, appeared during part of the clinic hours on certain days. Medical students were not assigned to the clinic. The nursing staff was present for the opening of the clinic at 12:30 p.m., and were responsible for registration and preliminary work-up of patients. House staff members and the secretary-clerk appeared around 1:00 p.m., as soon as their duties with one of the morning clinics were finished.

The clinic served adult (over twelve years of age) patients on a referral basis and by appointment only. Approximately thirty-two patients were scheduled each day. All patients received appointments for 10:30 a.m., at which time registration for all afternoon clinics opened. The nature of the illnesses ranged from minor to chronic. Most of the patients were on return or follow-up visits.

All patients of the MUSC Outpatients Department began their visit at the general registration desk by entering one of three queues: new

patients, lost card registration; self-pay registration; or, third party payment registration. A patient holding a valid clinic card reported directly to one of the two payment windows. If a problem with payment or a change in financial status was discovered at the payment window, the patient was directed to Financial Investigation before completing registration. A patient visiting the clinic for the first time, or one who had misplaced his clinic card, reported to the new patient, lost card window for preliminary admittance procedures and issuance of a clinic card. New patients and patients who had experienced a change in payment status then proceeded to Financial Investigation. All other patients went directly to the appropriate payment window to complete registration. Having completed registration, patients attending the General Medicine Clinic either reported directly to the clinic, or waited for the opening of the clinic, depending upon the time of their general registration.

Upon arrival at the General Medicine Clinic patients gave their name and outpatient clinic number to a registered nurse. Around 12:30 p.m. the registered nurses separated patient charts, checked for new or return patients, and assigned patients to the clinic doctors. The nurses tried to insure that returning patients saw the same doctor they had seen on their previous visit, and each doctor had no more than eight patients assigned to him for the afternoon session. Patients were called from the waiting room in groups of eight for registration and the service "height-weight-temperature (HWT)". Each patient was weighed, had his height measured, and had his name and outpatient number added to that day's clinic census sheet by a registered nurse. Then a second registered nurse took the patient's temperature and pulse while the first nurse serviced the next patient in the queue.

The nine examining rooms used by the General Medicine Clinic were the same used by a morning clinic whose hours ran from 8:00 a.m. until 12:00 noon. If the morning clinic had finished on time, the nurses began placing the patients who had completed registration-HWT in the examining rooms. Once the examining rooms were filled, patients returned to the waiting rooms until they were called for examination. Patients who had come to the clinic only for lab work ordered at a previous visit left at this time.

After examination by a physician, patients proceeded to the front desk where they returned their charts to the clerk. According to the doctor's written orders in the chart, the clerk made appointments for scheduled lab work and return visits. Patients exited the clinic at this point or had their lab work completed.

Labs usually required of General Medicine Clinic patients included: venipuncture (blood), EKG, EEG, pulmonary function, x-ray, and cytology-bacteriology. The labs, located in areas adjacent to the General Medicine Clinic, serviced patients from all of the MUSC outpatient clinics.

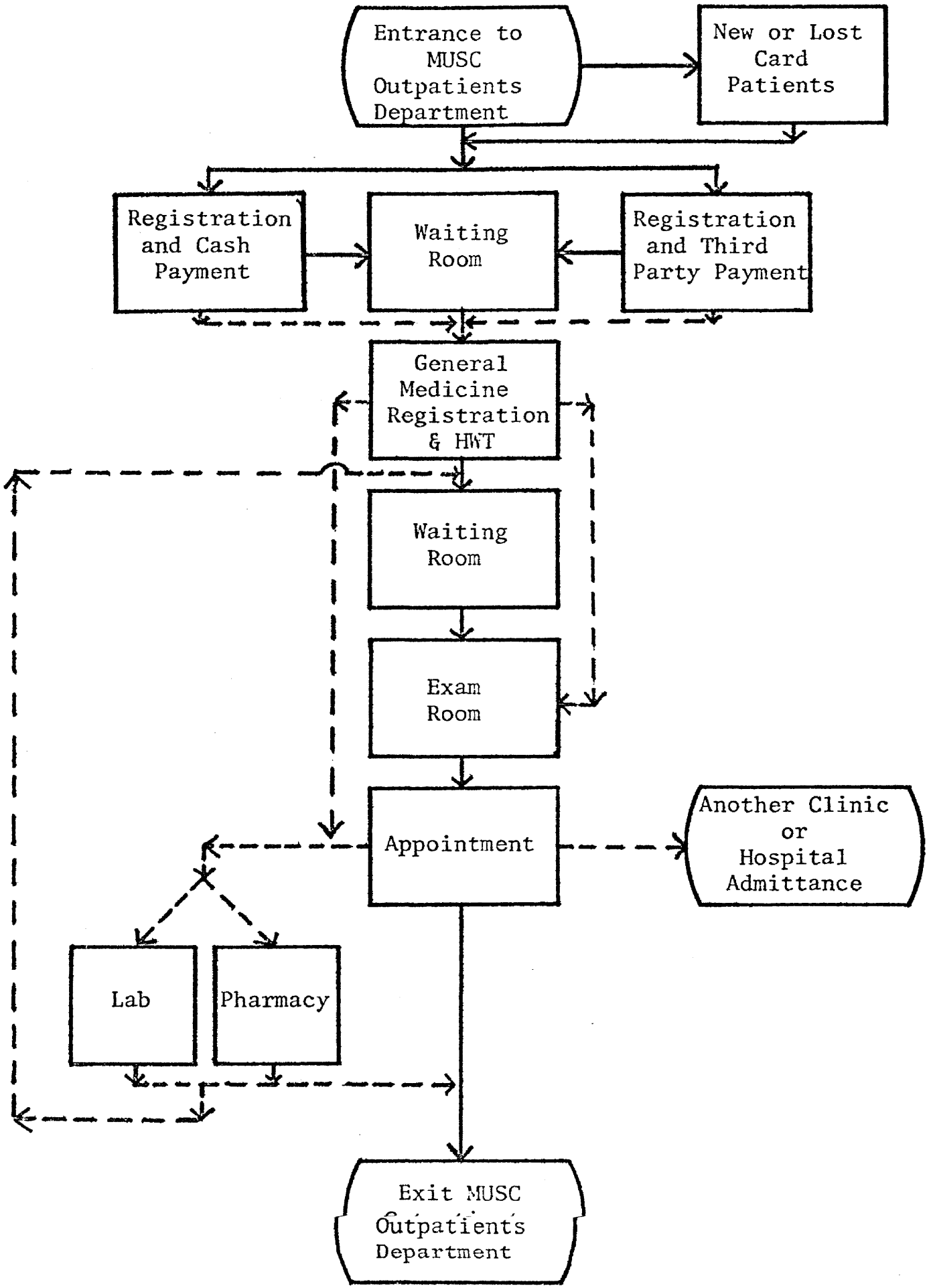
A flow diagram depicting the possible paths taken by a patient of the General Medicine Clinic is shown in Figure 2.1.

Sampling

A thorough study of the General Medicine Outpatient Clinic had to include detailed analyses of conditions affecting both the medical care providers and the receivers of that medical care. In addition, a study of the socio-economic characteristics of the patients and of factors influencing the patient arrival patterns was considered to be invaluable. Thus, the study of the General Medicine Clinic required three distinct

Figure 2.1

Patient Flow Diagram



data-gathering efforts: data collection of patient flow information, patient characteristics and work effort of the clinic staff.

To best conserve time and resources the three data collection efforts were carried out at the same time. This also allowed better interpretation of the results of the data, as far as cause and effect among the factors were concerned. Sampling of patient flow took place from August 1974 to October 1974 for twenty-one nonconsecutive days.* Demographic sampling was not collected on the first sampling date (8/05) and work sampling started on August 12, and was collected for the remaining eighteen days. This length of time for sampling permitted the evaluation team to observe the clinic through various patient loads and several house staff rotations. Members of the observation team were hired solely for data collection and assisted in similar evaluations of two speciality clinics at the MUSC on the days when the General Medicine Clinic was not being sampled. The observers were thoroughly briefed in the data collection procedures, which were based on those suggested by Sims in the Clinic Self-Evaluation Manual. Observers were cautioned not to interfere with clinic operation or patient movement in any way. An unavoidable bias to the data was expected however since the patients and more particularly the clinic staff were aware their actions were being monitored. This bias was thought to be small. Clinic activity was so high most of the time it was assumed that, after the observers' initial appearance, the presence of the observers would hardly be noticed.

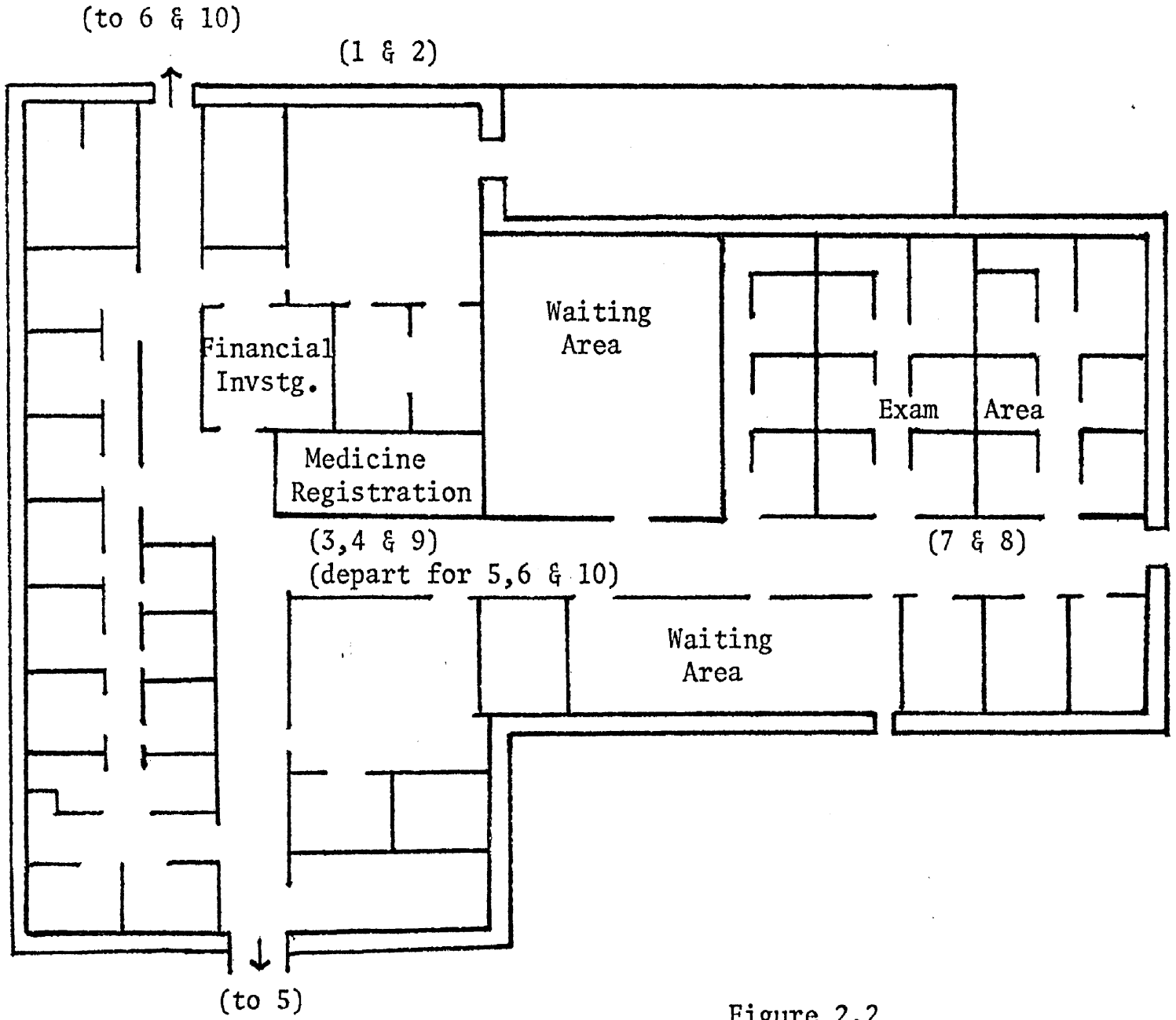
*(8/05,07,09,12,14,16,19,21,23,26,28,30; 9/16,18,20,23,25,27,30; 10/02, 04).

Patient Flow Data Collection

The first step in the patient flow data collection was to set up stations in the clinic, located in the general area where patients received various services. At these stations, shown in Figure 2.2, observers recorded for each patient time "in" and "out" of a particular service. Time "in" Station 3 (General Medicine registration) was recorded when the patient was called from the waiting room and joined the queue for service. Time "out" of Station 3 and time "in" Station 4 (height-weight-temperature, HWT) were recorded simultaneously when the patient stepped on the scale to be weighed. Time "in" and "out" Station 7 (exam) was recorded as the patient entered and departed the examination cubicle.

In order to determine the amount of time spent by a patient in the exam room prior to the arrival of the physician, the times the physician examination began and ended were monitored at Station 8. Observers clocked the time "in" at Station 9 (appointment/exit) as the patient stepped up to the desk to make the necessary lab schedules and return visit appointment. The patient's departure from the desk signalled time "out" of Station 9 and officially ended the General Medicine Clinic visit.

Two additional services (general registration and labs) which a patient received outside the General Medicine Clinic area were considered to have a definite impact on that time spent by a patient in the General Medicine Clinic. Stations 1 and 2 monitored the time General Medicine Clinic patients arrived at the MUSC Outpatients Department for general registration. Station 5 (blood lab), Station 6 (x-ray lab), and Station 10 (EKG lab) recorded three times for every lab visit: the time leaving the appointment desk, time of arrival at the lab and the time of departure



LEGEND

1: Registration & payment of fees in cash
2: Registration & third party payment
3: General Medicine registration
4: Height-weight-temperature
5: Blood lab
6: X-ray
7: Examination
8: Physician examination
9: Appointment & exit
10: EKG

Figure 2.2

Layout of Clinic and Station Locations

from the lab. From the first two observed times the evaluation team gained some idea of the amount of time needed by a patient to travel to and complete the queue for a particular lab.

Recording Patient Flow Data

At Station 3 as patients entered the queue for General Medicine, they were told by members of the evaluation team that a survey was underway, hopefully to improve clinic conditions, and were requested to wear identification tags while they were in the clinic. Sequence numbers, beginning with one and corresponding to the census sheet numbers, were written on the tags with a red pen.

As the patients moved through the clinic, observers recorded each time "in" and "out" of a station. Automatic time clocks were used to imprint each time in hundredths of an hour clearly and quickly on a hollerith (computer) card precoded with the station number. However, at Station 8 (physician examination) the doctors themselves wrote down the times the exam started and ended on a hollerith card attached to the patient's chart. Each day the doctors were reminded to synchronize their wristwatch with the time clock located outside the examination cubicles. It was felt that, in this manner, a better estimation of actual examination times could be obtained. At all stations each time "in" and "out" was stamped on a separate card. Times were recorded until the close of clinic.

Demographic Data Collection

Questionnaires were used to collect demographic data. Observers talked with the patients and filled in the questionnaires while the patients were in the waiting room or in the exam room before the doctor

had entered. Questions asked of the patients included: date of birth; sex; race; residence; marital status; number of persons in household; last grade in school completed; major mode of travel to clinic; miles travelled to clinic; travel costs to and from clinic. Additional information on the patients was obtained from copies of the daily census sheet. These sheets gave clinic sequence number, patient name, clinic outpatient number and sex. Also indicated were referral source (emergency room or receiving clinic) and whether or not the patient was new to the clinic.

Work Sampling Data Collection

In collection of the work sampling data, specific areas in the clinic were assigned to each observer. It was the observer's responsibility to determine each day before the start of clinic who was working within his (or her) area, and to what particular category of staff that person belonged: house staff, RN, LPN, or clerk. Maintaining a random pattern to their observation route, the observer passed through the clinic recording the activity of each professional and staff member, making three such observations rounds every hour for the duration of the clinic day.

Recorded activities for all staff categories were selected from an activity list drawn up after consultation with the clinic director, medical staff, and clinic staff. This list, shown in Figure 2.3, divided activities into four major groupings: Patient Care, Consulting, Administrative and Nonproductive activities. If more than one activity were observed, only the most significant was recorded. By no means does the heading "Nonproductive" imply that the observed activity was necessarily wasted time. This grouping included all uses of time which were nonproductive to the clinic, or had very little bearing on the efficiency of the General

Figure 2.3

Activity List for All Staff Categories

of the General Medicine Clinic

1. PATIENT CARE ACTIVITIES

   A. Examining patients
   B. Writing prescription/Lab orders
   C. Reading patient case data
   D. Instructing patients
   E. Determining urgency of case
   F. Assigning patients to examining rooms
   G. Assisting doctors
   H. Special nursing procedures
   I. Taking height, weight and temperature
   J. Collecting lab specimens
   K. Entertaining/aiding patients

2. CONSULTING ACTIVITIES

   A. Consulting with faculty/senior physicians
   B. Waiting for consultation

3. ADMINISTRATIVE ACTIVITIES

   A. Writing references and letters
   B. Reviewing chart and transcribing in chart
   C. Telephoning for records and data
   D. Assigning nurses
   E. Making appointments
   F. Obtaining lab data
   G. Registering patients
   H. Getting charts, or looking for charts
   I. Using telephone
   J. Unassigned duty
   K. Doing office work

4. NONPRODUCTIVE ACTIVITIES

   A. Waiting for facilities
   B. Out of clinic, location unknown
   C. On duty, idle
   D. Out of clinic, attending a meeting
   E. Out of clinic, in some other clinic
   F. Out of clinic, at lunch
   G. Out of clinic, in class
   H. Out of clinic, sick
   I. Out of clinic, on break
   J. Out of clinic, gone for the day

Medicine Outpatient Clinic.

General Survey Procedures

Each sampling day the one observer scheduled for Stations 1 and 2 reported at 10:30 a.m. and continued clocking arrival times until around 1:00 p.m. By this time of day all patients reporting to the General Medicine Clinic on time had completed their general clinic registration. Two observers manned the time clock located at the General Medicine registration desk and recorded observations for Stations 3, 4 and 9. A time clock located outside the examination cubicles was used to record Station 7 times by two observers who also collected the Station 8 cards from the physicians at the end of each examination. Each of the three labs (Stations 5, 6 and 10) had an observer and a time clock to record patient flow data.

Work sampling data was collected by two observers. Demographic data collection also needed two observers, but data collection was usually finished by 1:30 p.m.. All observers (except the Station 1 and 2 observer) reported to the clinic at 12:00 noon in preparation for the 12:30 p.m. opening. At the end of the sampling day all patient flow time cards, demographic questionnaires, work sampling activity sheets and the xerox copy of the clinic census sheet were collected.

Data Management

Preparation of the data for eventual computer analysis began with the keypunching of the data collected over the sampling period onto hollerith cards. Work sampling and demographic data were keypunched onto cards in a fixed format from the activity sheets and the questionnaires. Variables

composing a work sampling record included: date of observation in the order MM/DD/YY; name of the clinic staff member observed; staff position in clinic; time of observation; observed activity (as recorded from the activity list). The eighteen questions asked of the patients during the survey formed a patient's demographic record.

Keypunching of the patient flow data was simplified greatly since the information was already contained on the card. This also reduced the possibility of introducing error into the data if transcription had been necessary. Variables on the card included: an eight integer patient ID where the first six integers represented the observation date and the last two integers were the patient's sequence number; a two integer station number indicating the type of clinic service involved; the time the observation was recorded as a four digit integer. Since times at Station 1 and 2 were recorded before the patients had received their sequence number, these cards contained as variables the observation date, the station number, the patient's clinic outpatient number and the time the observation was recorded. By matching the outpatient number on the Station 1 and 2 cards with the outpatient number from the proper census sheet, a patient's sequence number was found, and all the variables mentioned above were then included on the Station 1 and 2 cards.

Through the use of computer programs which sorted the patient flow data by observation date, patient sequence number, station number and observation time, the patient flow information was arranged in record form. This data, as well as the work sampling and demographic data, was in the necessary form required for entry into the data bank.

The information system used, the Multi-Purpose Information Processor (MIP), was installed by the Department of Biometry on the MUSC IBM 370/145.

It is a series of 370 Assembler Language programs which provide for: creation and maintenance of a data bank (MIP DATA BANK), retrieval, manipulation and display of selected information from the data bank (MIP QUESTRAN), and processing of records in the data bank (MIP PROCESSOR) [14]. Through the use of the QUESTRAN and PROCESSOR functions the majority of the summary statistics on the patient flow, work measurement and demographic studies were generated. Additional statistics were obtained using the BMD statistical package [2].

Chapter III

THE DEMOGRAPHIC STUDY

Patient Load

Over the twenty-one sampling days, 682 visits to the General Medicine Outpatient Clinic were made by 623 patients, with an average of 32.48 patients being seen each day. Fifty patients made two visits to the clinic during the sampling period, three patients made three visits, and one patient visited the clinic four times. The mean value for visits per patient was 1.09, with approximately nine percent of the sample visiting the clinic at least twice during the sampling period.

Population Characteristics

In number of visits to the clinic, females outnumbered males three to one. The black race accounted for almost ninety percent of the visits. As seen in Table 3.1, thirty-eight percent of the patients sampled were married, thirty-two percent were widowed, and twenty-two percent were single.

During the sampling period, the clinic served patients ranging in age from thirteen to ninety-nine. The average age of the patient was approximately fifty-seven years ($s_{\bar{x}} = 2.38$, $n = 610$). As seen in Figure 3.1, the General Medicine Clinic served a predominately older group of patients with forty-eight percent of the sample being between fifty and sixty-nine years of age, and sixty-eight percent between forty and sixty-nine years

Table 3.1

Sex, Race and Marital Status

By Number and Percentage of Visits

Sex

	n	%
Females	479	76.52
Males	147	23.48
Total	626	100.00

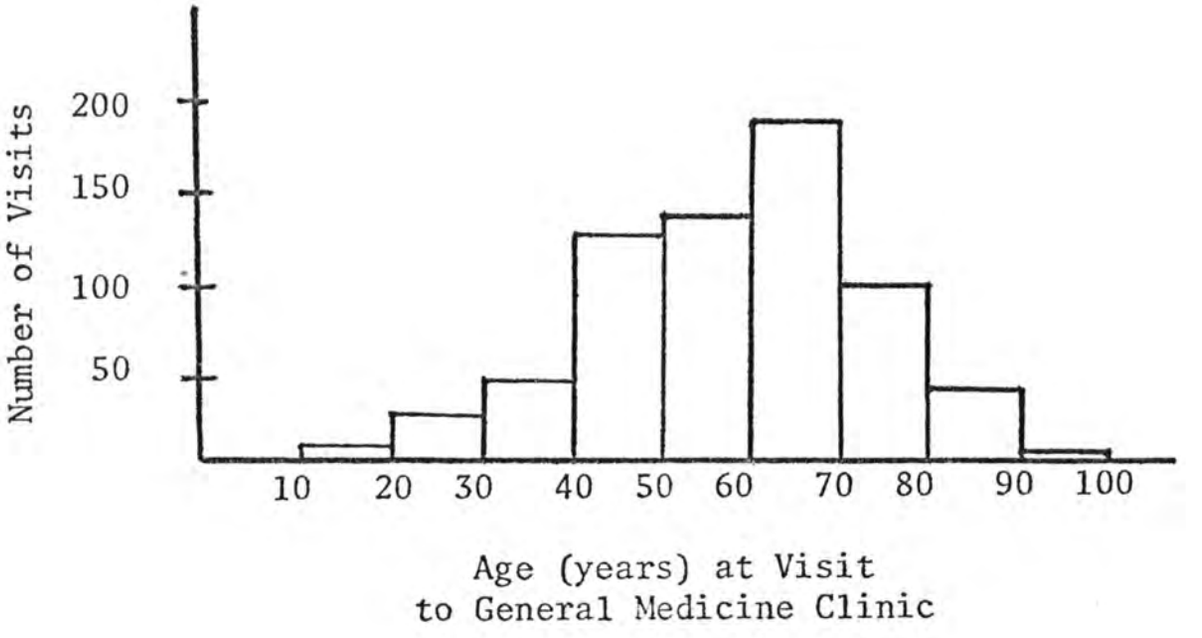
Race

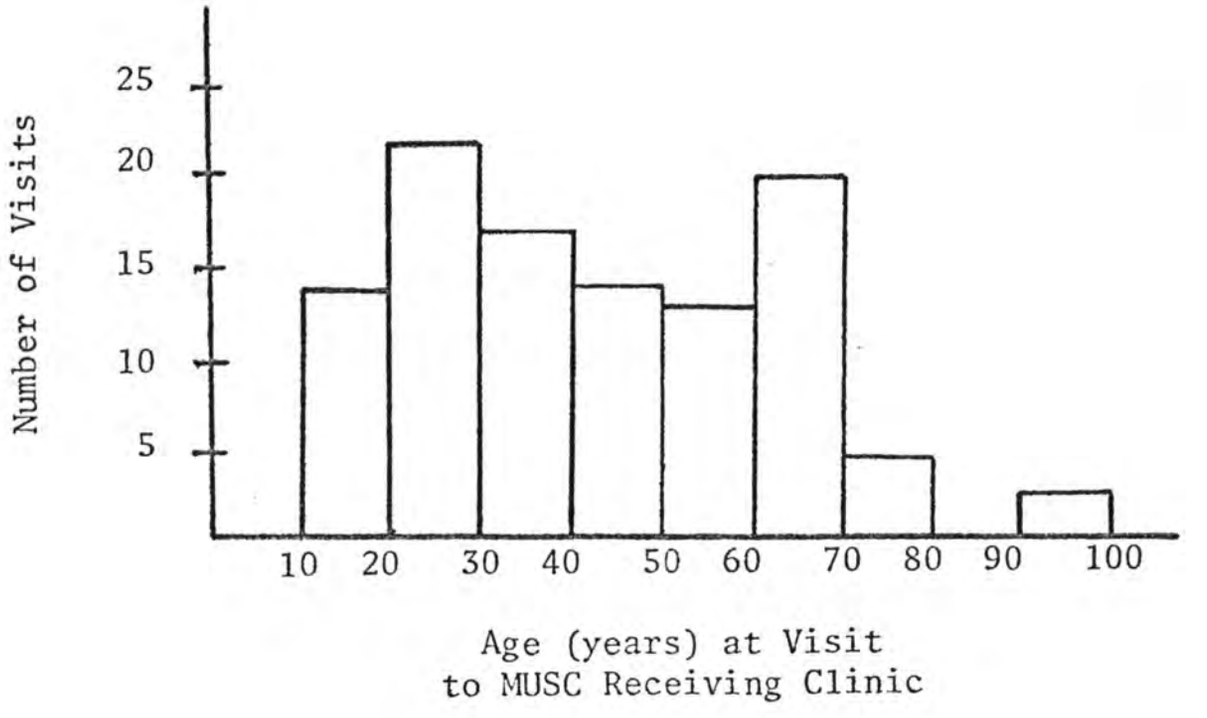
	n	%
Black	553	88.34
White	72	11.50
Other	1	0.16
Total	626	100.00

Marital Status

	n	%
Married	232	37.30
Widowed	200	32.15
Single	133	21.38
Separated, Divorced	57	9.16
Total	622	100.00

Figure 3.1
Distributions of Age at Visit to General Medicine Clinic and MUSC Receiving Clinic





of age. Twenty percent of the patients were seventy years of age or older. For comparative purposes, the age distribution of a random sample of one hundred patients from the MUSC Receiving Clinic is also presented in Figure 3.1.

The distribution of educational levels as measured by the last school grade completed is shown in Figure 3.2. The mean educational level of the patients was at the sixth grade ($s_{\bar{X}} = 0.30$, $n = 586$). Amount of formal education ranged from none at all to four years of college. Forty-six percent of the patients had less than a sixth grade education, while eighty percent had less than a tenth grade education.

Figure 3.3 presents the distributions of the number of people in the household and the number of children. Of the households represented by the patients sampled, the average number of persons in the household was 3.56 ($s_{\bar{X}} = 0.18$, $n = 618$). Households ranged in size from one person living alone to a family with twenty-four members. However, more than half of the patients (60%) came from households of three persons or less, and almost twenty-one percent of the patients lived alone. The mean number of children was 4.29 ($s_{\bar{X}} = 0.23$, $n = 611$), with a range from zero to twenty-four. Fifty percent of the patients had four or more children.

Residence and Mode of Transportation

The distance a patient lives from the clinic and the means by which the patient gets to and from the clinic can be indicative of his socioeconomic position and may also directly affect the operation of that clinical system. Slightly more than half (58%) of the patients of the General Medicine Outpatient Clinic came from an urban setting, with forty-two percent having come from rural areas. Table 3.2 presents the distance the

Figure 3.2

Distribution of Educational Level

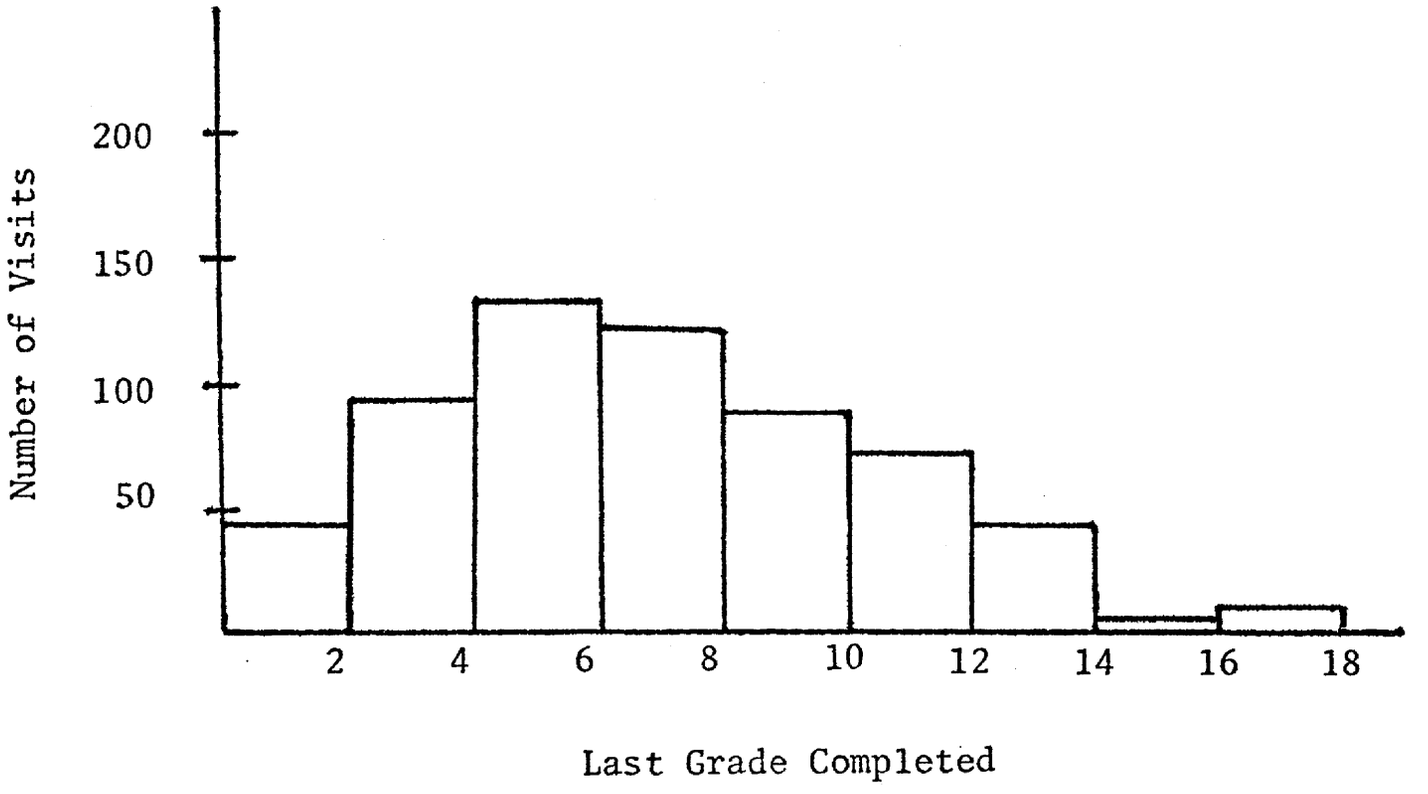
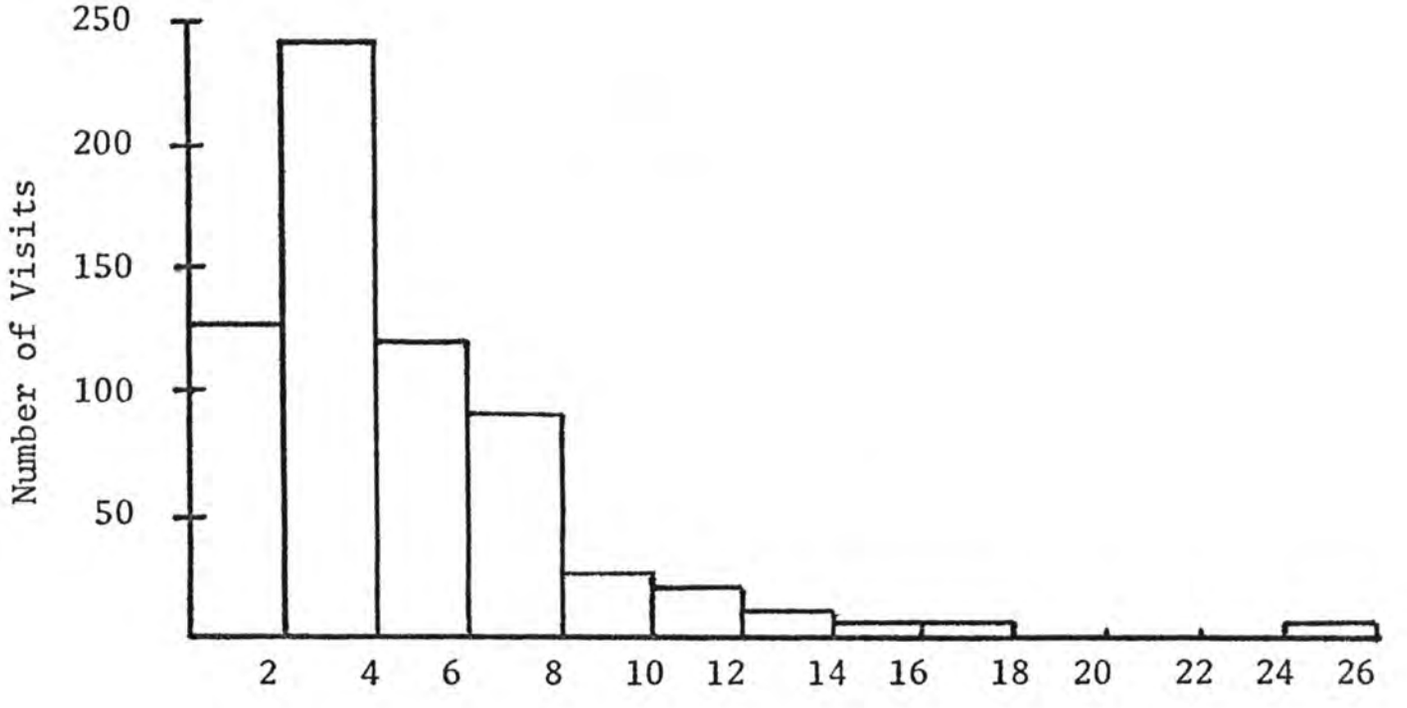
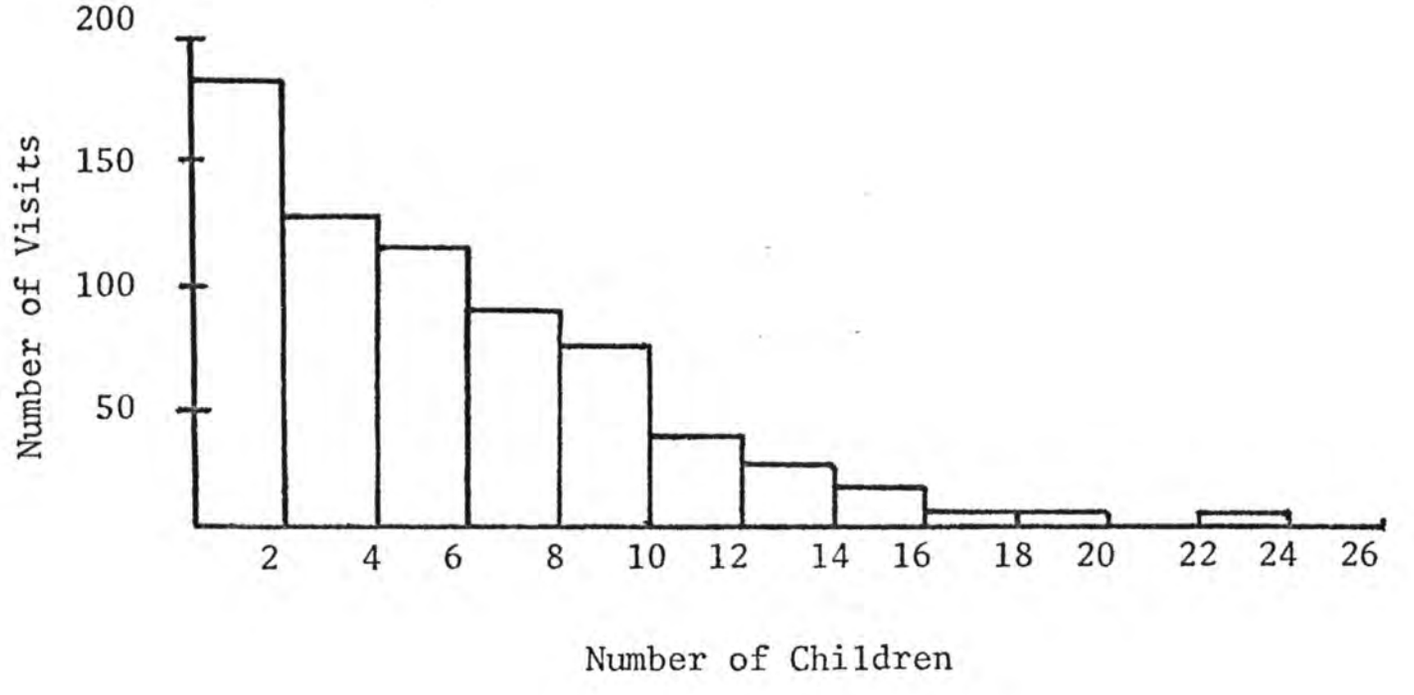


Figure 3.3
Distributions of Number of People in Household
and Number of Children





patient travelled in terms of actual mileage from the clinic. Fifty-four percent of the sample lived between one and ten miles from the clinic. Twenty-nine percent of the patients lived more than fifteen miles from the clinic, with nine percent travelling more than thirty miles to attend the clinic.

Table 3.2

Distance Travelled to Clinic

	n	%
Less than 1 mile	36	5.78
Between 1 and 5 miles	207	33.23
Between 6 and 10 miles	127	20.38
Between 11 and 15 miles	75	12.04
Between 16 and 20 miles	51	8.19
Between 21 and 25 miles	38	6.10
Between 26 and 30 miles	31	4.98
More than 30 miles	58	9.31
Total	623	100.00

While the Medical University has been considered to be a hospital serving the health needs of residents throughout the State of South Carolina, it can be seen that it is in fact operating as a regional institution. Based on responses to the demographic questionnaire, ninety percent of the visits to the General Medicine Clinic were from Charleston county, with eight percent from Berkeley and Dorchester counties. Thus, the "Trident" region alone was responsible for ninety-eight percent of the visits to the General Medicine Clinic.

The number and percentage of visits categorized by the different modes of transportation used by the patients are given in Table 3.3. Almost one-third (31%) of the sample rode the city bus, while one fourth had a friend or relative bring them to the clinic. Approximately seven percent were in walking distance of the clinic and only fourteen percent had or were able to use a family car.

Table 3.3

Mode of Travel

	n	%
Family car	88	14.08
City bus	196	31.36
Taxi cab	64	10.24
Friend's or relative's car	159	25.44
Walked	43	6.88
Other	75	12.00
Total	625	100.00

According to the demographic questionnaire, on the average the patient spent eighty-seven cents in getting to the clinic ($s_{\bar{x}}$ = \$0.08, n = 544) and eighty-one cents returning home ($s_{\bar{x}}$ = \$0.07, n = 528). These costs were primarily incurred through bus and taxi fares, money paid to friends or relatives for a ride, and estimates of gasoline used by the family car. Almost ninety-two percent of the patients intended to use the same form of transportation returning home as they had used in coming to the clinic. After the clinic visit was over, thirty-six percent of the patients had to wait for their ride before returning home.

With sixty-seven percent of the patients of the General Medicine Clinic having to rely on buses, taxis or friends' cars to attend the clinic, a transportation system operated by the university or the state should have a high rate of utilization. Results from this demographic study would suggest an investigation into the cost effectiveness of such a system. Design considerations would need to study utilization patterns of patients not only from the university clinics, but also from other health agencies and outpatient departments located in the immediate area.

Clinical Considerations

Over the sampling period only two percent (13) of the patients were new to the General Medicine Outpatient Clinic. Approximately five percent (31) of the patients were referred to the clinic from the MUSC Receiving Clinic. Eleven patients were referred from the Charleston County Emergency Room and one patient was referred from the MUSC Ear-Nose-Throat Clinic.

The method of financial payments for the 494 General Medicine Clinic patients whose arrival times were recorded at Stations 1 and 2 was divided almost equally between cash payment (53%) and third party payment (47%).

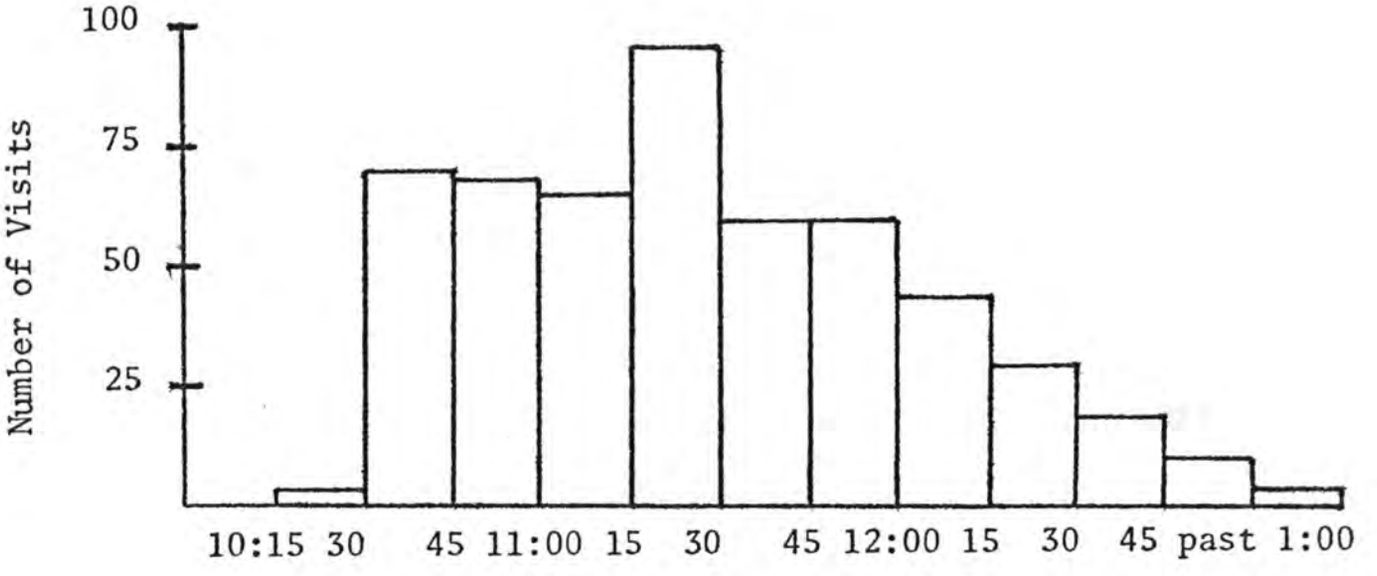
The distributions of the patients' arrival times at general registration and General Medicine registration are presented in Figure 3.4. The arrival times at general registration are evenly distributed from 10:30 a.m. to 12:00 noon. Approximately eighty-two percent of the sample had arrived by 11:00 a.m., only one-half hour after general registration had opened for the afternoon clinics. Five percent of the patients registered after 12:30 p.m., the opening time of the General Medicine Clinic.

In the clinic itself, approximately forty-eight percent of the patients had been called for registration by 12:45 p.m.. By 1:00 p.m., when the

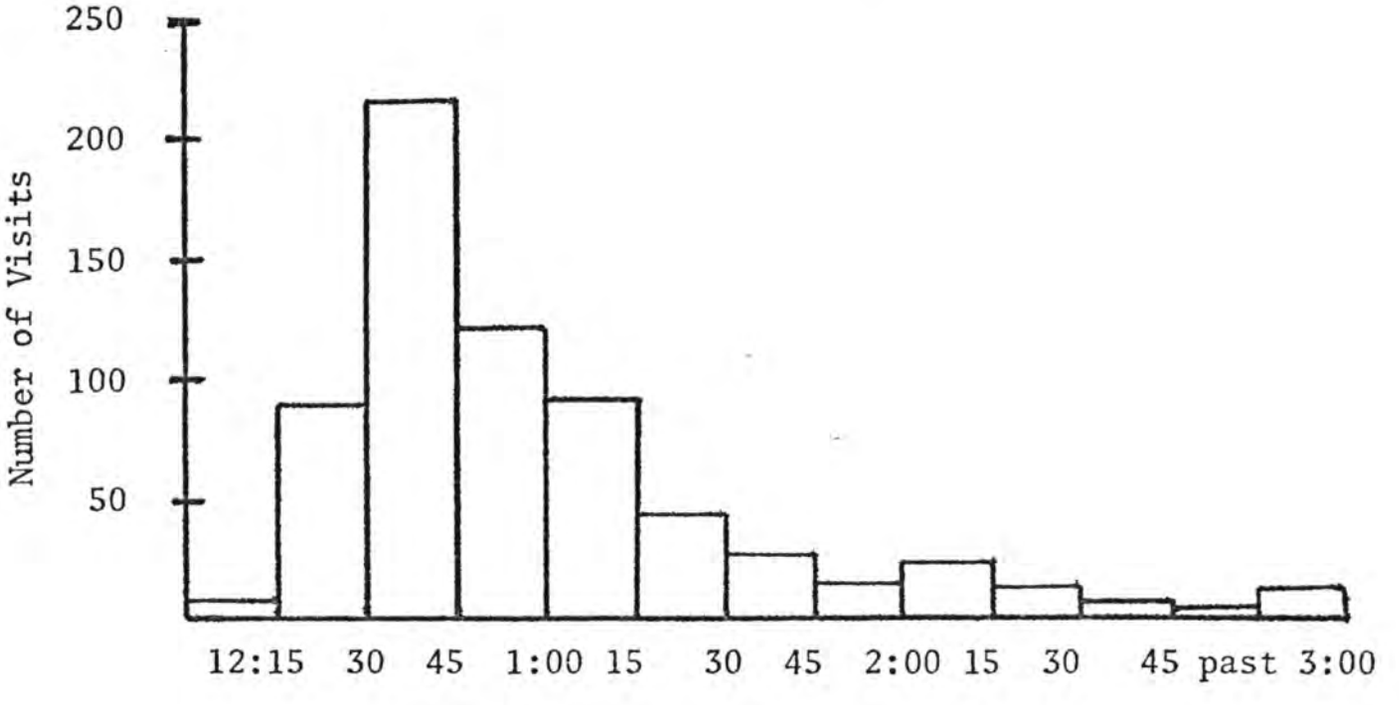
Figure 3.4

Distributions of Arrival Times at

General Registration and General Medicine Registration



Arrival Time at General Registration



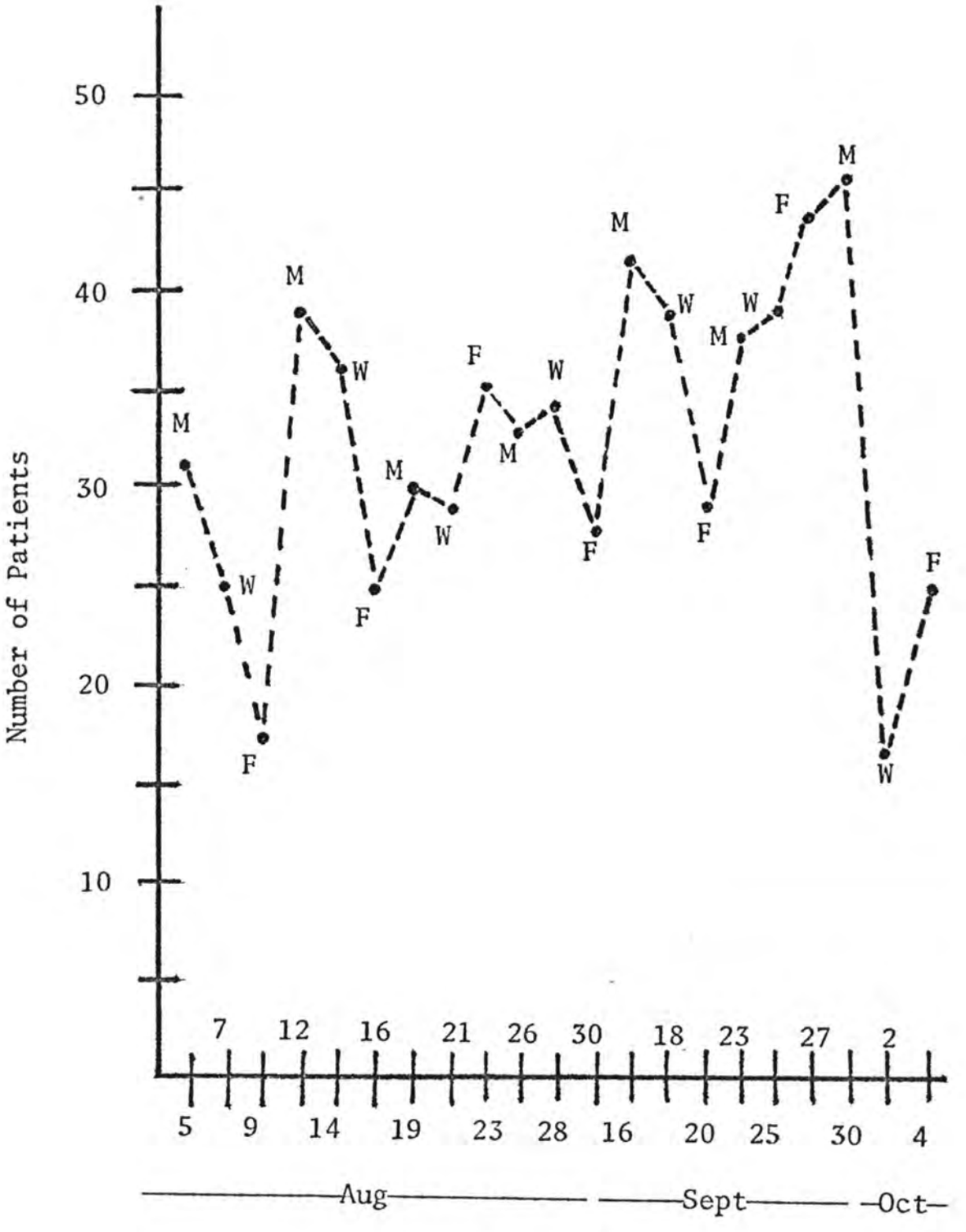
Arrival Time at General Medicine Registration

doctors usually arrived in the clinic, sixty-seven percent of the patients had registered for the clinic. Nearly seven percent of the patients registered after 2:00 p.m., and were primarily late arrivals.

The examination of the patient arrival times in Figure 3.4 revealed for the first time a problem inherent in the appointment system used by the clinic. Patients, many of whom would have visits extending far into the afternoon, were all scheduled to arrive at the General Medicine Clinic at one time. Since the university required a separate registration earlier in the morning, some patients were spending all day in the clinic, with much of this as waiting time. A discussion of the relationships among the block appointment system, the patient arrival patterns, and the operation of the clinic will be presented in Chapter IV.

The daily patient loads are shown in Figure 3.5. In four of the seven Monday-Wednesday-Friday sampling periods, Monday was the day of the week with the heaviest patient load. Over the sampling period the mean patient load was 36.71 patients for Monday, 31.28 patients for Wednesday, and 29.43 patients for Friday.

Figure 3.5
Patient Load on Sampling Days



Chapter IV

THE PATIENT FLOW ANALYSIS

Patient Arrival Patterns

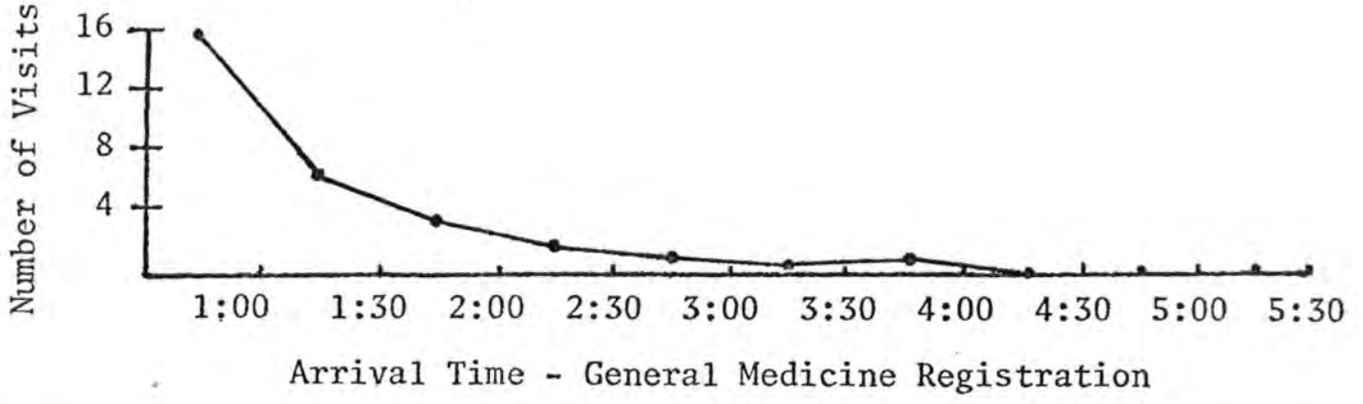
The distribution of the number of patients arriving in a half-hour at each clinic activity over the average clinic day are shown in Figure 4.1. While a separate graph has been given for each activity for reasons of clarity, the best method of interpreting the figure may be to compare the arrivals at each activity over a specified time period. Thus, for the first hour of the General Medicine Clinic, the number of patient arrivals was high for registration and height-weight-temperature. Eight patients arrived at examination during this first hour. As expected, not many of the patients had completed their clinic visit an hour after clinic opening time, and only a few patients had arrived at the appointment and exit station by 1:30 p.m.

From 1:30 p.m. to 4:00 p.m., the clinic was involved primarily in patient examination. The few patients who arrived at registration/height-weight-temperature were principally late-arrivals. The number of patients arriving at examination maintained a fairly steady rate of approximately four patients each half-hour. The number of patients making appointments increased and peaked during this period as the majority of the patients either completed their visit or made the necessary preparations for lab work.

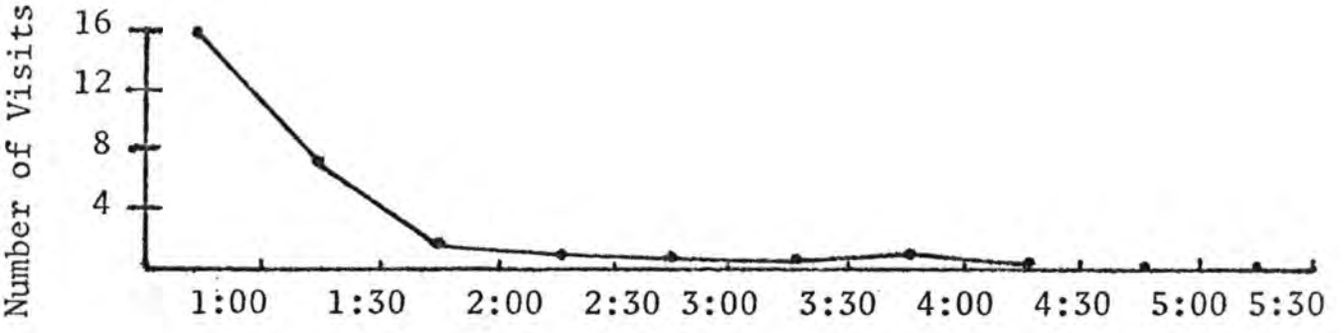
Figure 4.1

Distributions of Patient Arrivals by Station

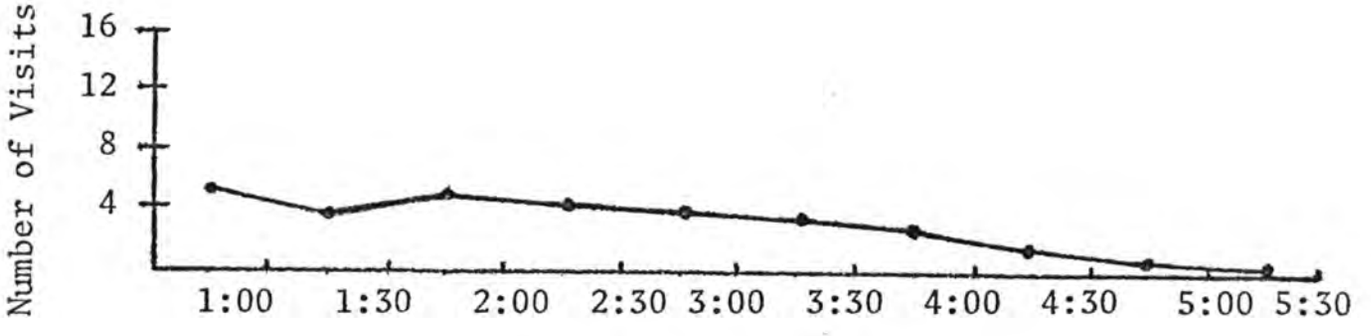
Over the Average Clinic Day



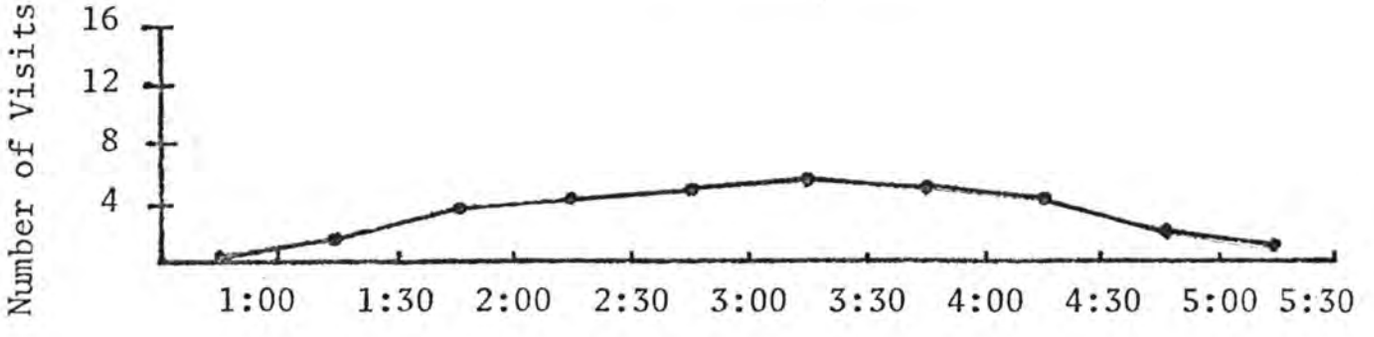
Arrival Time - General Medicine Registration



Arrival Time - HWT



Arrival Time - Exam



Arrival Time - Appointment

Activities in the clinic were winding down from 4:00 p.m. to 5:30 p.m.. The services registration/height-weight-temperature had essentially closed since no patients arrived at the General Medicine Clinic during this period. Patients were still arriving for examinations but not at the rate previously seen. The busiest activity in terms of rate of patient arrivals was appointment and exit. This, however, steadily decreased over the interval as patients exited the General Medicine Clinic.

Mean Queue and Service Times

The average length of time spent by a patient waiting for a service or receiving service is presented in Table 4.1. In addition, the average clinic visit time and the average amount of time a patient waited for service throughout the visit are shown in this figure.

A more graphic display (as suggested by Sims) of the mean queue and service times is given in Figure 4.2. By this method, the relative amounts of time spent waiting for service and actually being served may be readily compared. Note that the queue and service times for physician exam have been nested within the service time for examination. It will be recalled that the examination portion of a patient's visit began the moment the patient entered the examination cubicle. Service for the physician exam began once the doctor arrived. Thus, the sum of the queue and service times for the physician exam equals the service time for the clinic activity examination.

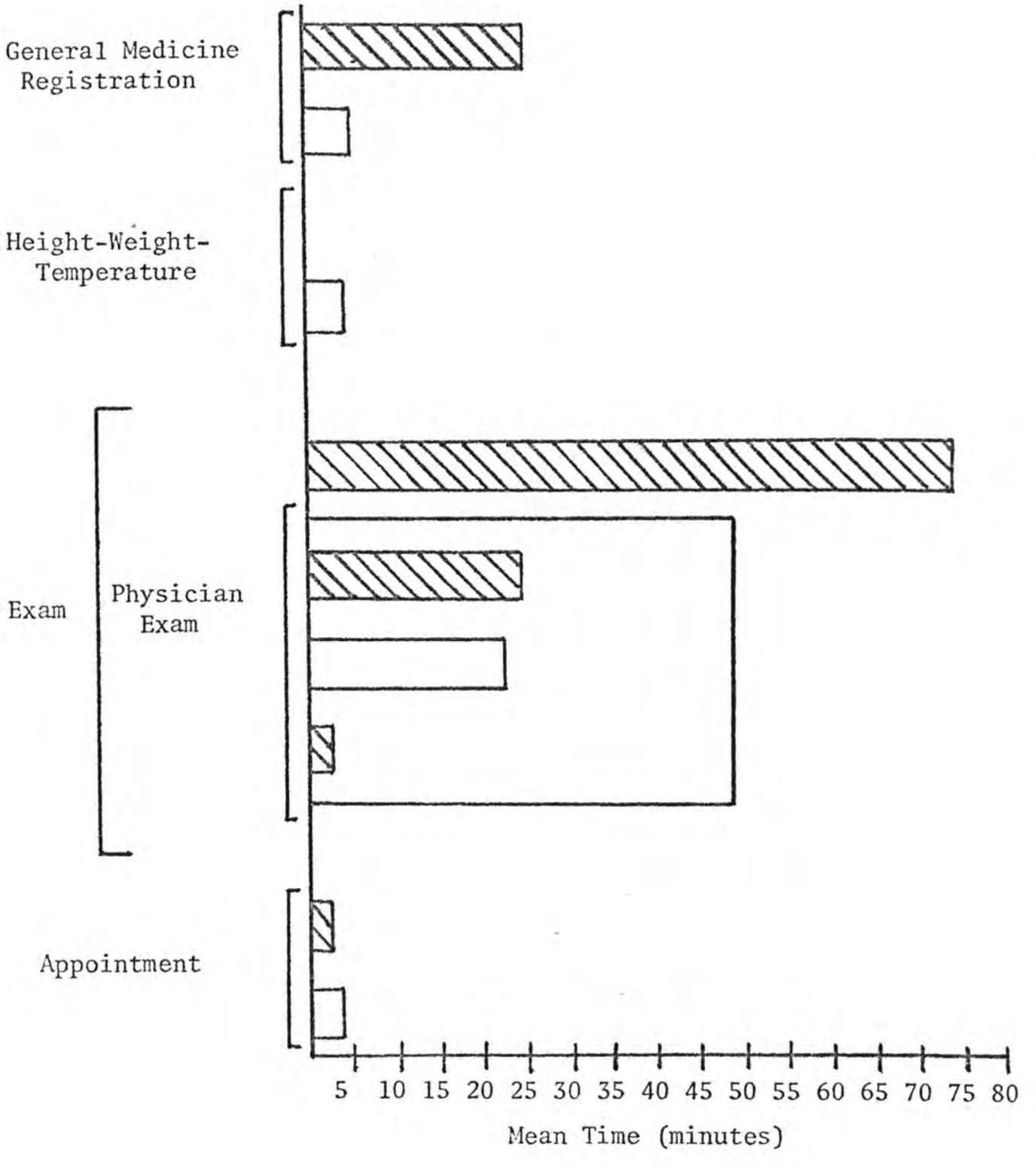
Table 4.1

Characteristics of Distributions

ACTIVITY	NO. OF OBSERVATIONS	MEAN TIME HOURS	MEAN TIME MINUTES
General Medicine Reg.			
Queue	492	0.41	24.6
Service	618	0.07	4.2
Height-Weight-Temperature			
Queue	0	0.00	0.0
Service	622	0.06	3.6
Examination			
Queue	548	1.23	73.8
Service	475	0.81	48.6
Physician Examination			
Queue before doctor enters	475	0.40	24.0
Service	475	0.38	22.8
Queue after doctor leaves	475	0.03	1.8
Appointment and exit			
Queue	384	0.03	1.8
Service	600	0.06	3.6
Clinic visit time	458	2.76	165.6
Total wait time	210	2.08	124.8

Figure 4.2

Mean Queue and Service Times



Frequency Distributions

Frequency distributions of the patients' queue times and service times are presented in this section for each clinic activity. Frequency distributions are also included for the clinic visit time, total wait time, wait/visit index and the service times for the laboratory visits.

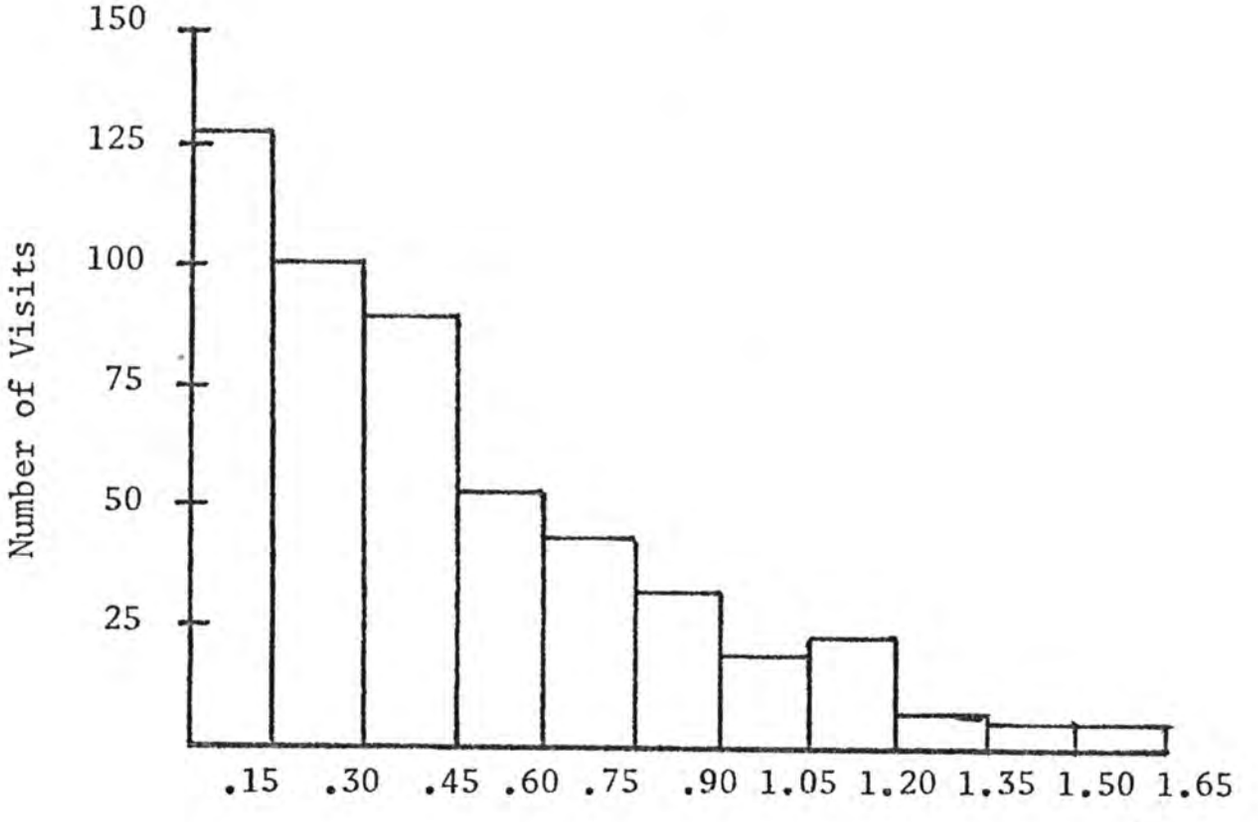
GENERAL MEDICINE REGISTRATION

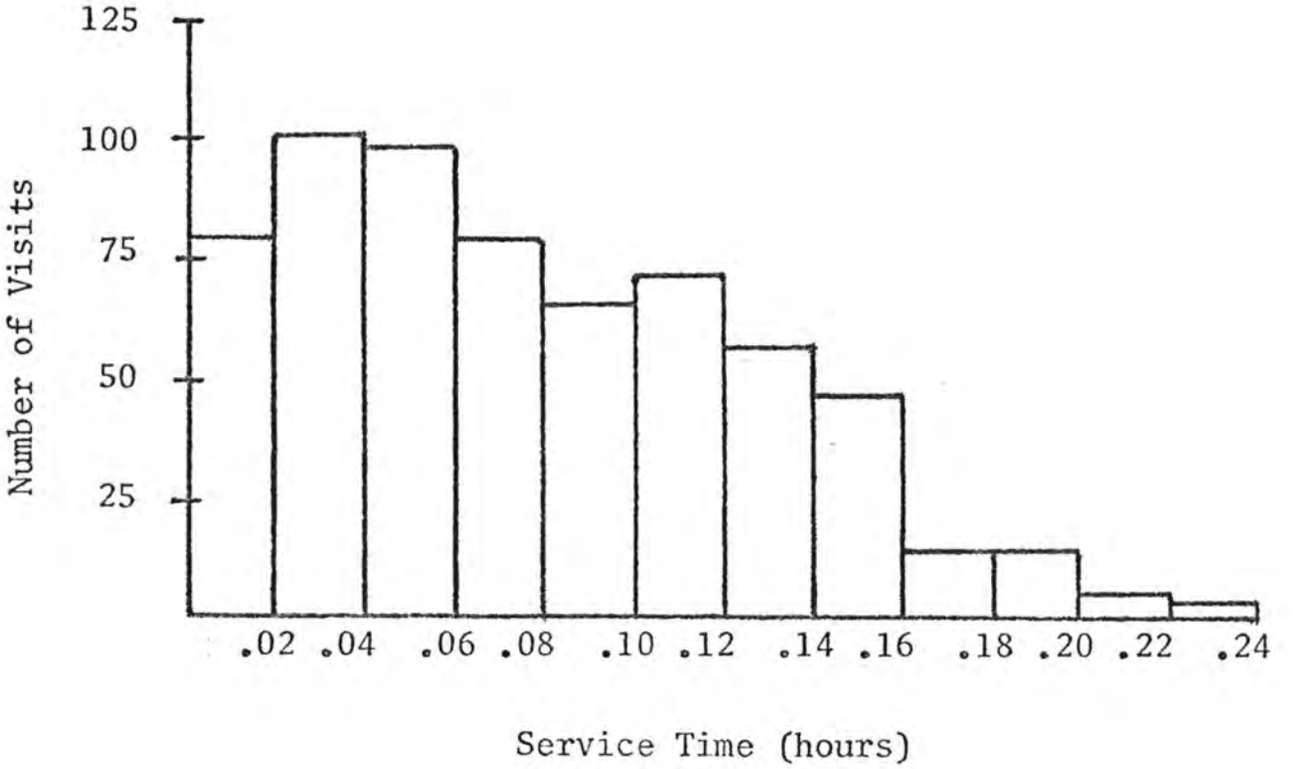
The frequency distributions for the queue and service times of the General Medicine registration are shown in Figure 4.3.

The mean queue time preceding the registration to the General Medicine Clinic was approximately twenty-five minutes. The queue was calculated as that length of time which occurred after 12:30 p.m. and lasted until the patient's registration started. Those few patients who registered before 12:30 p.m., the official clinic opening time, were considered to have no queue time. Sixty-two percent of the patients had queue times less than the mean queue time, and twenty-six percent waited less than 0.15 hour (9.0 minutes). Slightly more than seven percent of the patients had to wait more than an hour for registration.

The mean service time for General Medicine registration was 0.07 hour (4.2 minutes), with fifty-seven percent of the patients having service times less than the mean. Approximately twenty-nine percent of the patients took less than 0.04 hour (2.4 minutes), while only five percent required more than 0.16 hour (9.6 minutes) to complete registration.

Figure 4.3
Distributions of Queue and Service Times
for General Medicine Registration





HEIGHT-WEIGHT-TEMPERATURE

The frequency distribution of the service times for height-weight-temperature is presented in Figure 4.4.

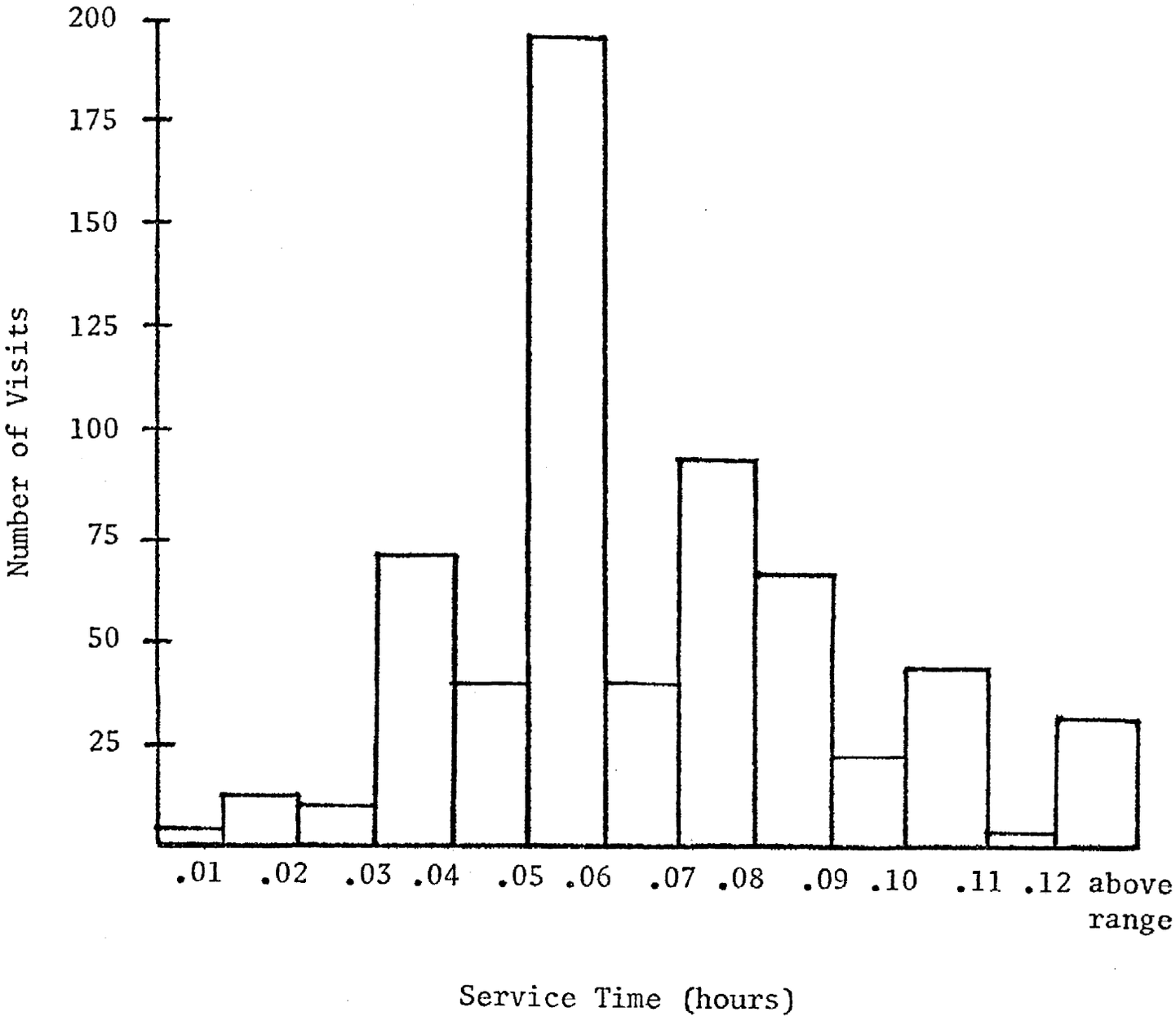
Since the start of height-weight-temperature and the close of General Medicine registration occurred simultaneously, patients did not experience a queue for height-weight-temperature.

The mean service time was 0.06 hour (3.6 minutes). Sixty-one percent of the patients had a service time less than the mean. Approximately twelve percent of the patients took longer than 0.10 hour (6.0 minutes) to process through height-weight-temperature.

Figure 4.4

Distribution of Service Times for

Height - Weight - Temperature



EXAMINATION

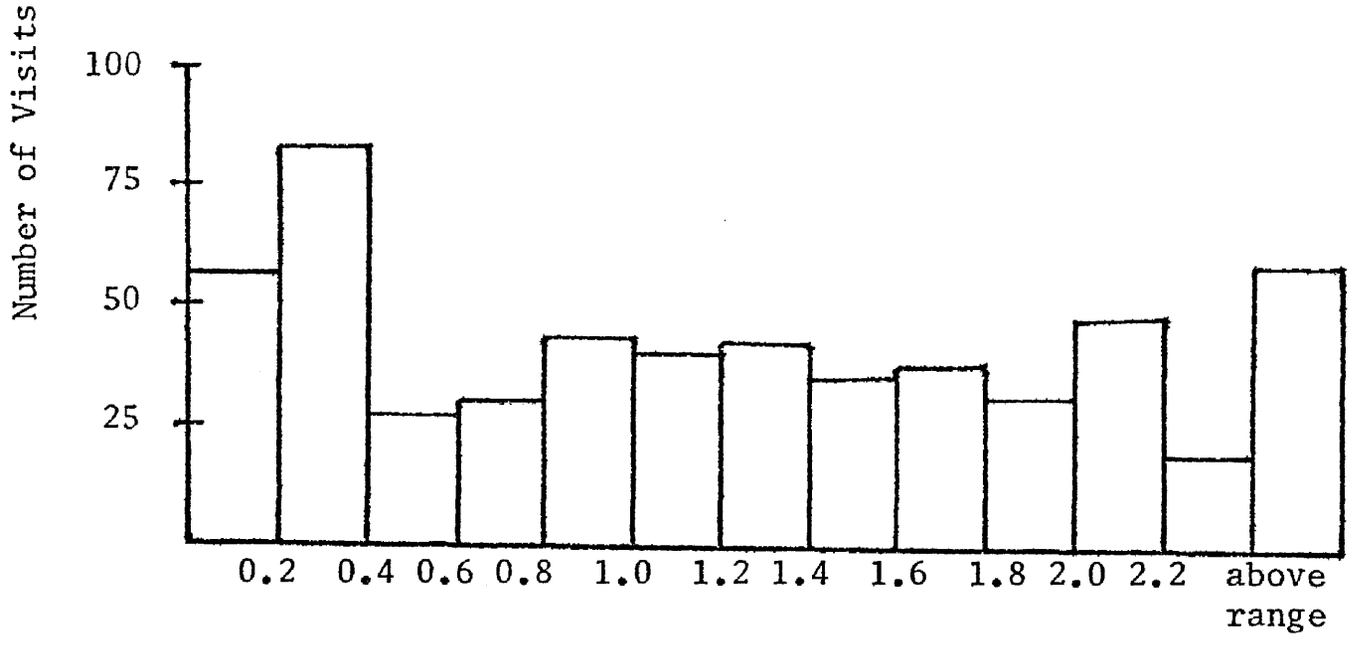
Figure 4.5 displays the frequency distributions of the queue and service times for examination.

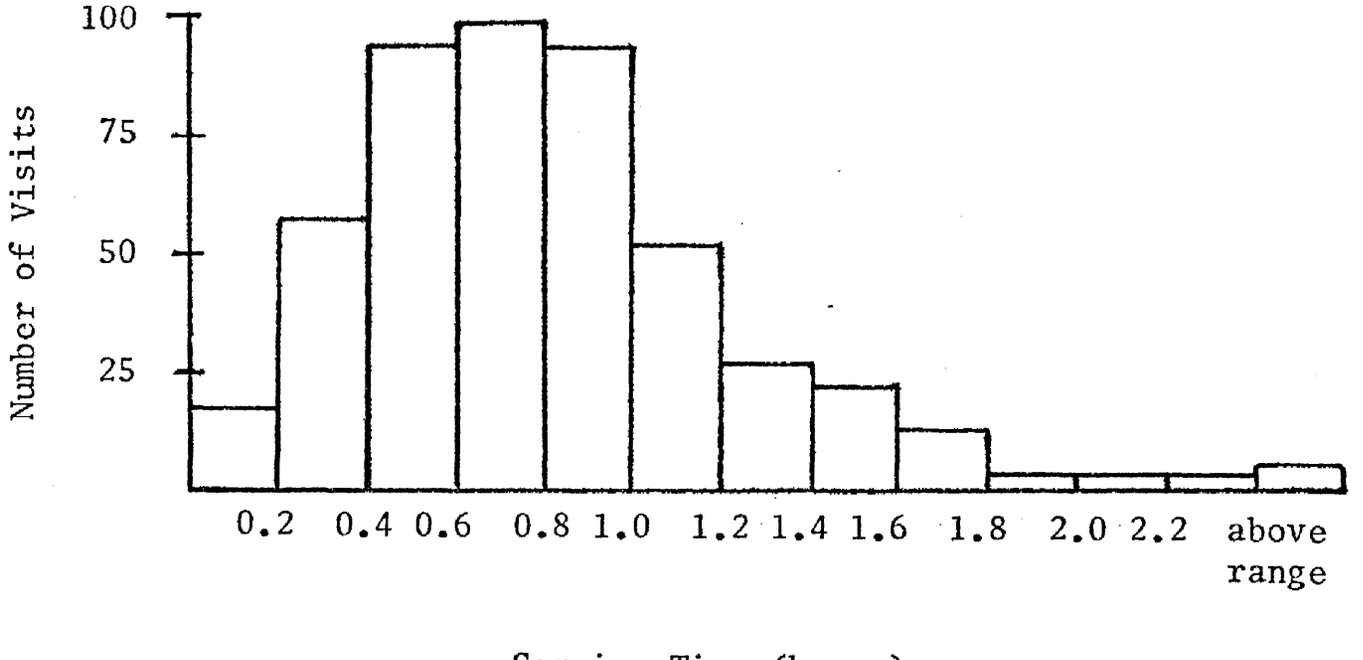
The mean queue time before entering the exam room was 1.23 hour (73.8 minutes), with fifty-four percent of the patients having to wait less. Approximately twenty-six percent of the patients had queue times of less than 0.40 hour (24.0 minutes), and eleven percent waited less than 0.20 hour (12.0 minutes) before entering the exam room. However, twenty-three percent of the patients had queue times in excess of two hours.

On the average, a patient spent 0.81 hour (48.6 minutes) in the examination room. Fifty-seven percent of the patients had service times less than the mean. Sixteen percent finished the examination portion of their clinic visit in less than 0.40 hour (24.0 minutes). Twenty-six percent of the patients remained in the examination room an hour or more.

Figure 4.5

Distributions of Queue and Service Times for Examination





PHYSICIAN EXAMINATION

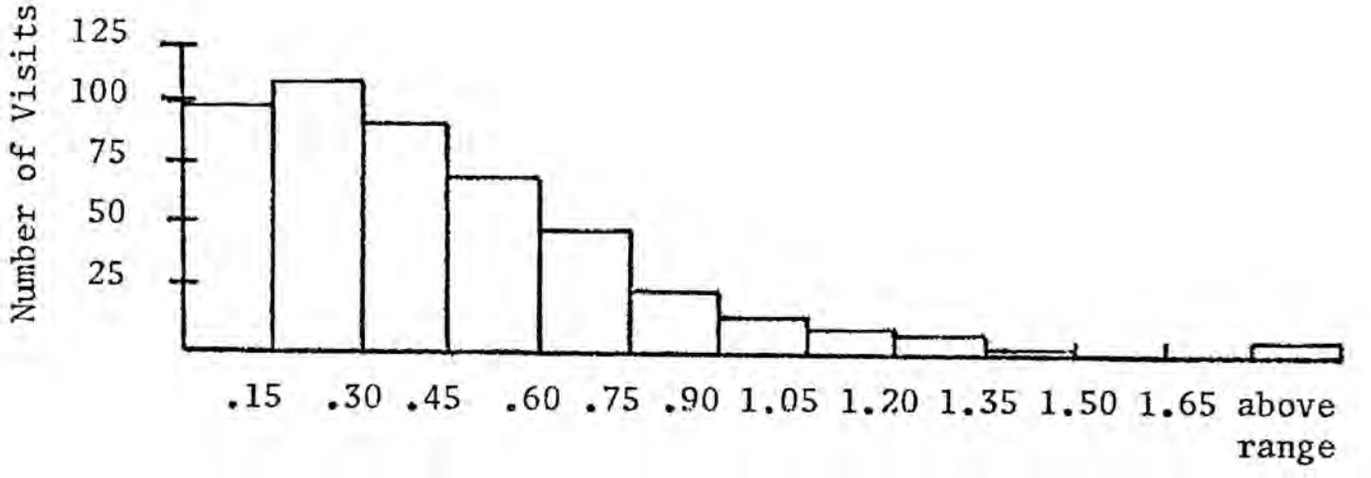
The frequency distributions of the queue and service times for the physician examination are presented in Figure 4.6.

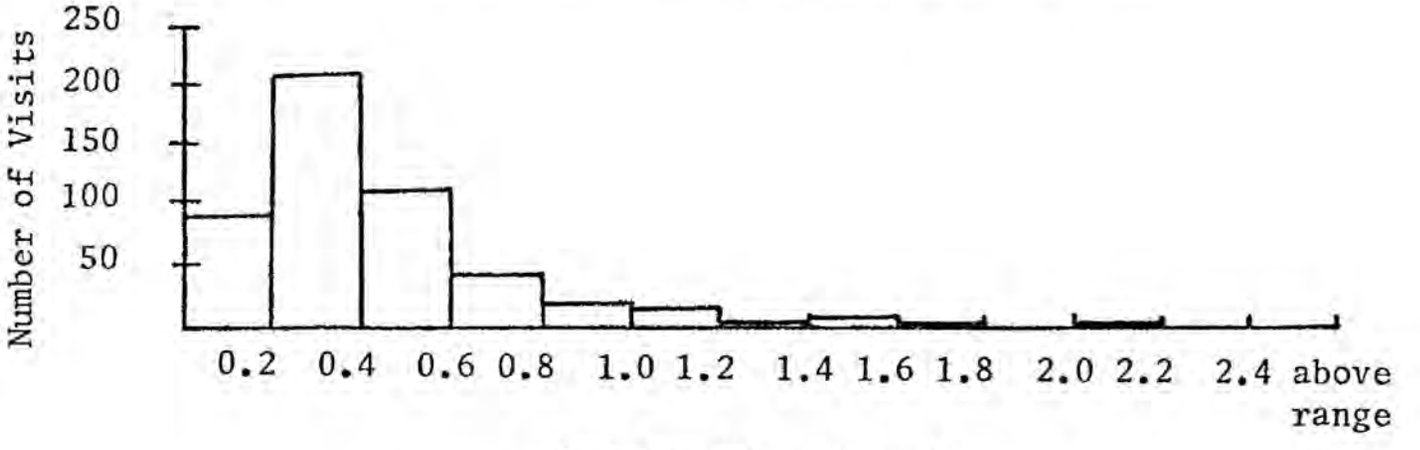
The mean queue time preceding the doctor's entrance to the examination room was 0.40 hour (24.0 minutes), with fifty-nine percent of the patients waiting less than the mean. Twenty percent of the patients had queue of 0.15 hour (9.0 minutes) or less. Only eleven percent waited 0.75 hour (45 minutes) or more for the doctor to arrive, while approximately four percent had to wait longer than 1.05 hour (63.0 minutes).

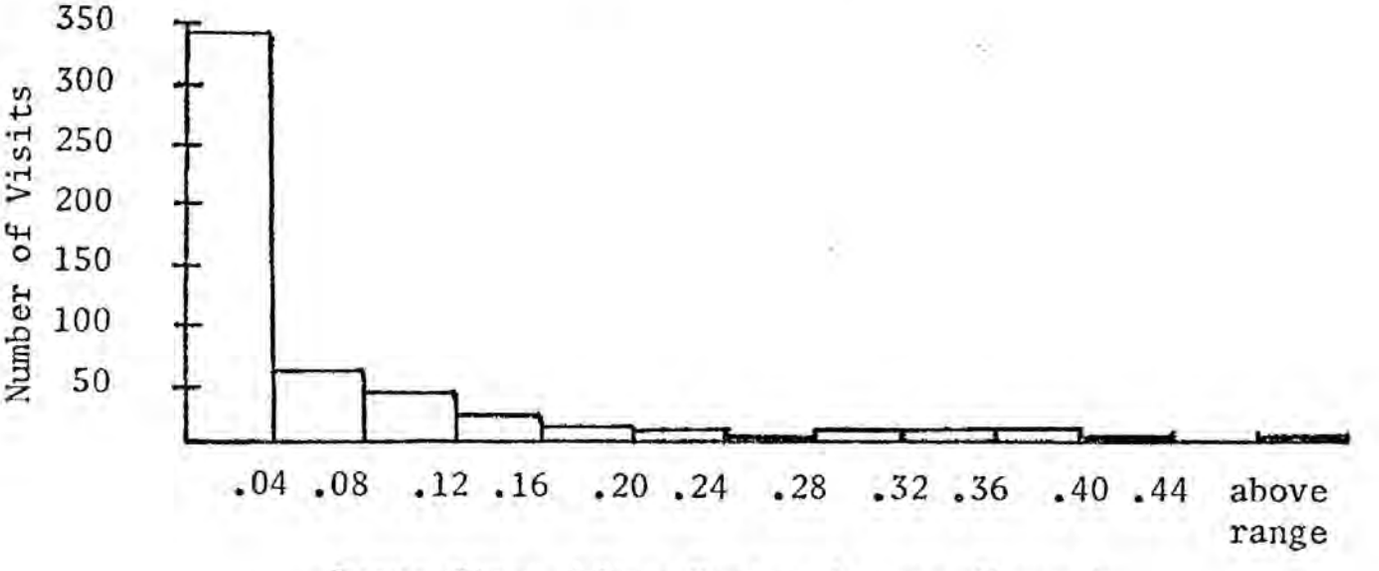
The actual time the physician stayed in the examination room averaged 0.38 hour (22.9 minutes). Sixty-two percent of the patients had physician examination times less than or equal to the mean. Nineteen percent of the patients experienced a physician examination time of less than 0.20 hour (12.0 minutes), while only approximately four percent were with the doctor longer than an hour.

After the physician examination had been concluded and the doctor had departed the exam room, the patient took an average of 0.03 hour (1.8 minutes) to get dressed, gather his belongings, and leave the room. Although not in the true sense a queue or waiting time, it is really a non-service time. Nevertheless, it is necessary in giving an accurate account of the patient's time in the examination room. Seventy-one percent of the patients had times less than the mean. In fact, almost half of the observed patients had a queue time equal to zero; that is, the patient departed the exam room before the doctor. Approximately twelve percent of the patients took 0.10 hour (6.0 minutes) or longer to prepare to leave.

Figure 4.6
Distributions of Queue and Service Times
for Physician Examination







APPOINTMENT AND EXIT

The frequency distributions of the queue and service times for appointment and exit are displayed in Figure 4.7.

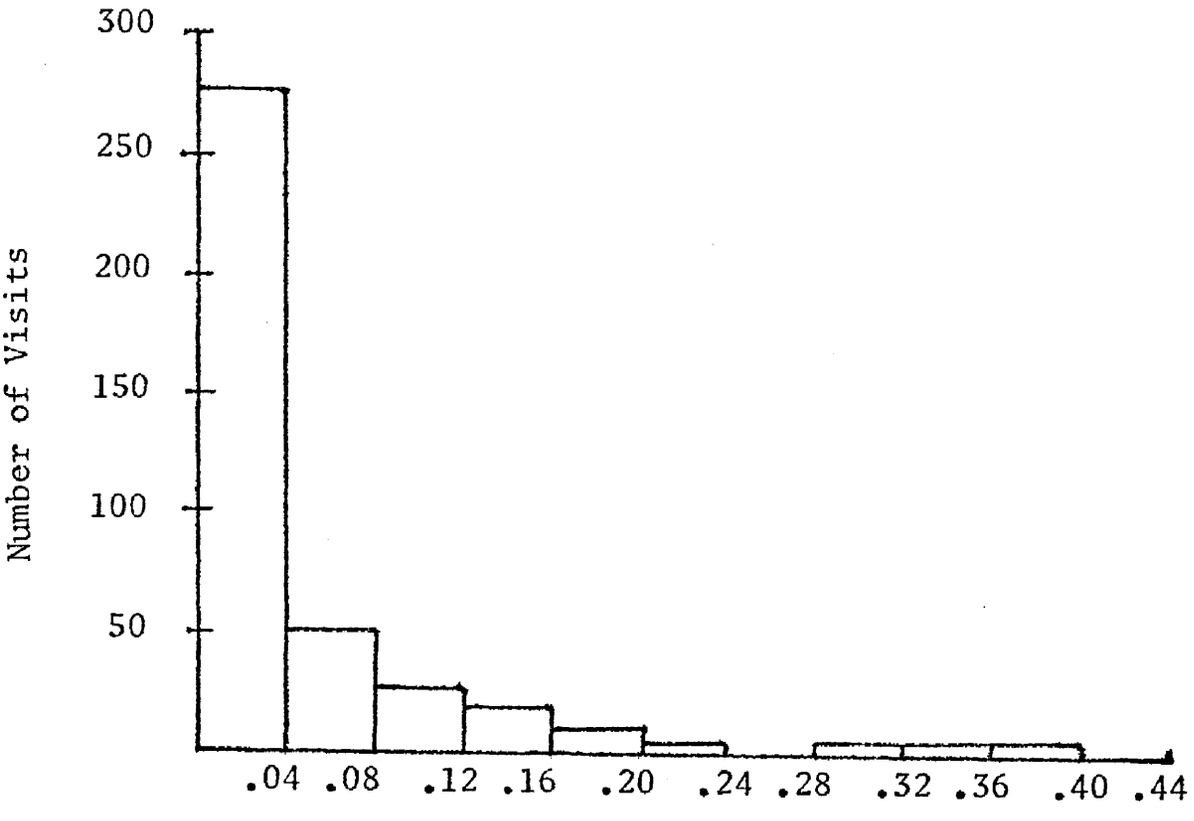
The mean queue time preceding the appointment service was 0.03 hour (1.8 minutes), with seventy-three percent of the patients observed having times less than the mean. This queue time included the time it took a patient to travel from the exam rooms to the appointment desk. Only one percent of the patients waited 0.20 hour (12.0 minutes) or longer before making an appointment.

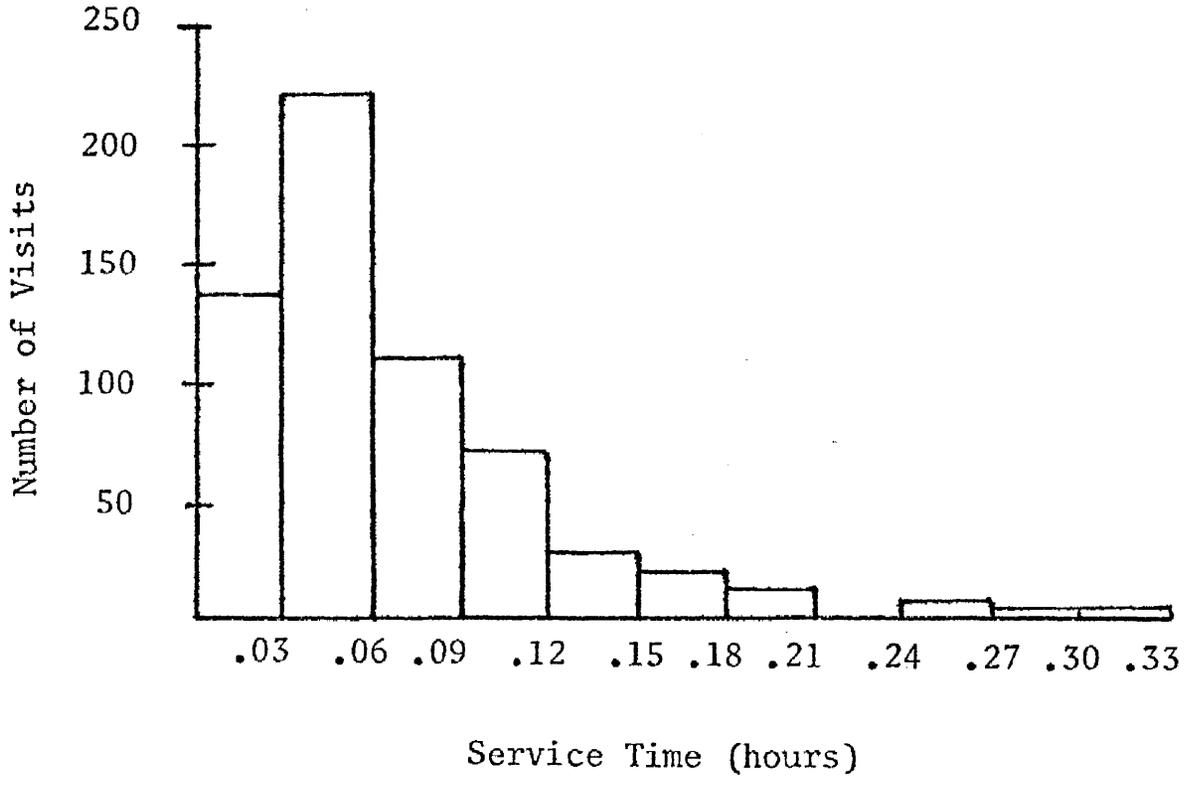
The average time a patient spent in making a return appointment and/or scheduling lab work was 0.06 hour (3.6 minutes). Fifty-nine percent of the patients had service times less than the mean. Only six percent of the patients took 0.15 hour (9.0 minutes) or longer to complete this service.

Figure 4.7

Distributions of Queue and Service Times

for Appointment and Exit





CLINIC VISIT TIME, TOTAL WAITING TIME, WAIT/VISIT INDEX

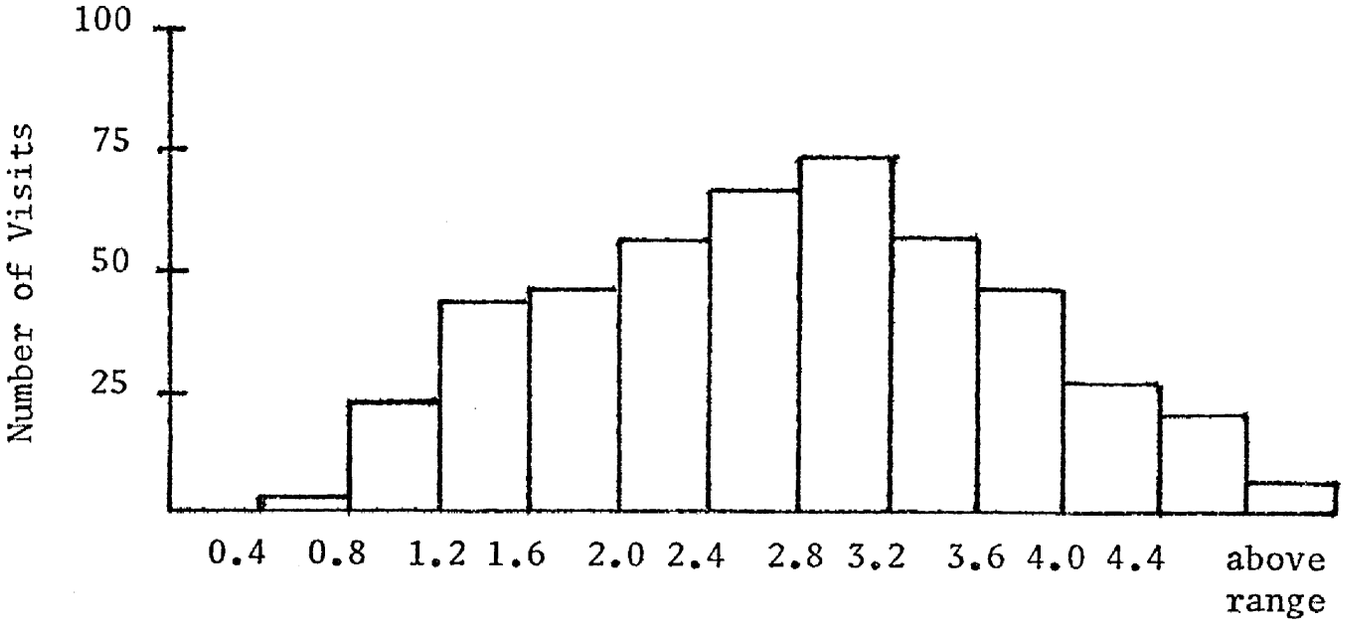
Frequency distributions of the clinic visit times and the total waiting times are shown in Figure 4.8. The frequency distribution of the wait/visit indices is presented in Figure 4.9.

The average visit to the General Medicine Clinic lasted 2.76 hours (165.6 minutes). Fifty-nine percent of the patients had visit times less than the mean. Only five percent of the patients completed their clinic visit in less than 1.20 hours (72 minutes), and almost eleven percent of the patients had clinic visit lengths in excess of four hours.

The mean total waiting time was 2.08 hours (124.8 minutes), with fifty percent of the patients having total waiting times less than the mean. A total waiting time of 1.20 hours (72 minutes) or less was experienced by twenty-two percent of the patients. Sixteen percent, however, waited in the clinic for over 3.20 hours (192 minutes).

In his Clinic Self-Evaluation Manual, Sims suggested the usefulness of a variable formed by dividing a patient's total waiting time by his clinic visit time. This variable, the wait/visit index, expresses on a scale from zero to one the proportion of a patient's visit consumed by waiting. The mean wait/visit index for the General Medicine Clinic was 0.75. Thus, on the average a patient waited for service for three-fourths of his clinic visit. Fifty-one percent of the patients had wait/visit indices greater than 0.80; that is, eighty percent or more of their time in clinic consisted of wait time. Only six percent of the patients had wait/visit indices 0.50 or less.

Figure 4.8
Distributions of Clinic Visit Times
and Total Waiting Times



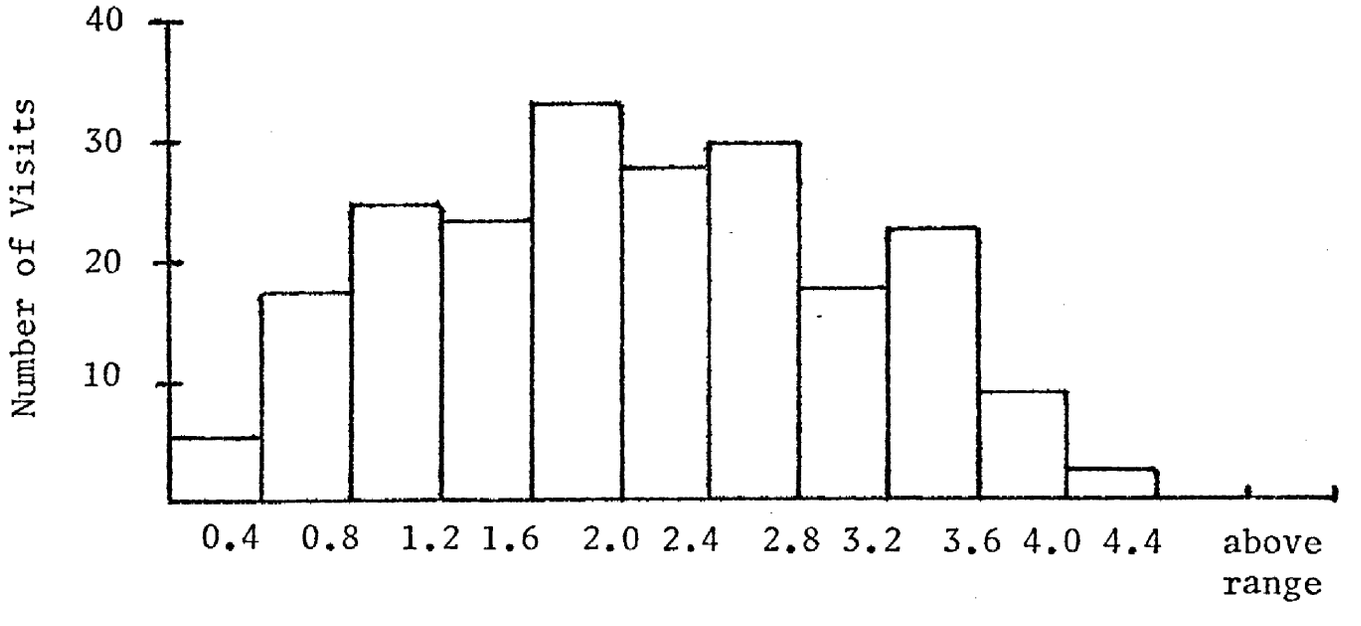
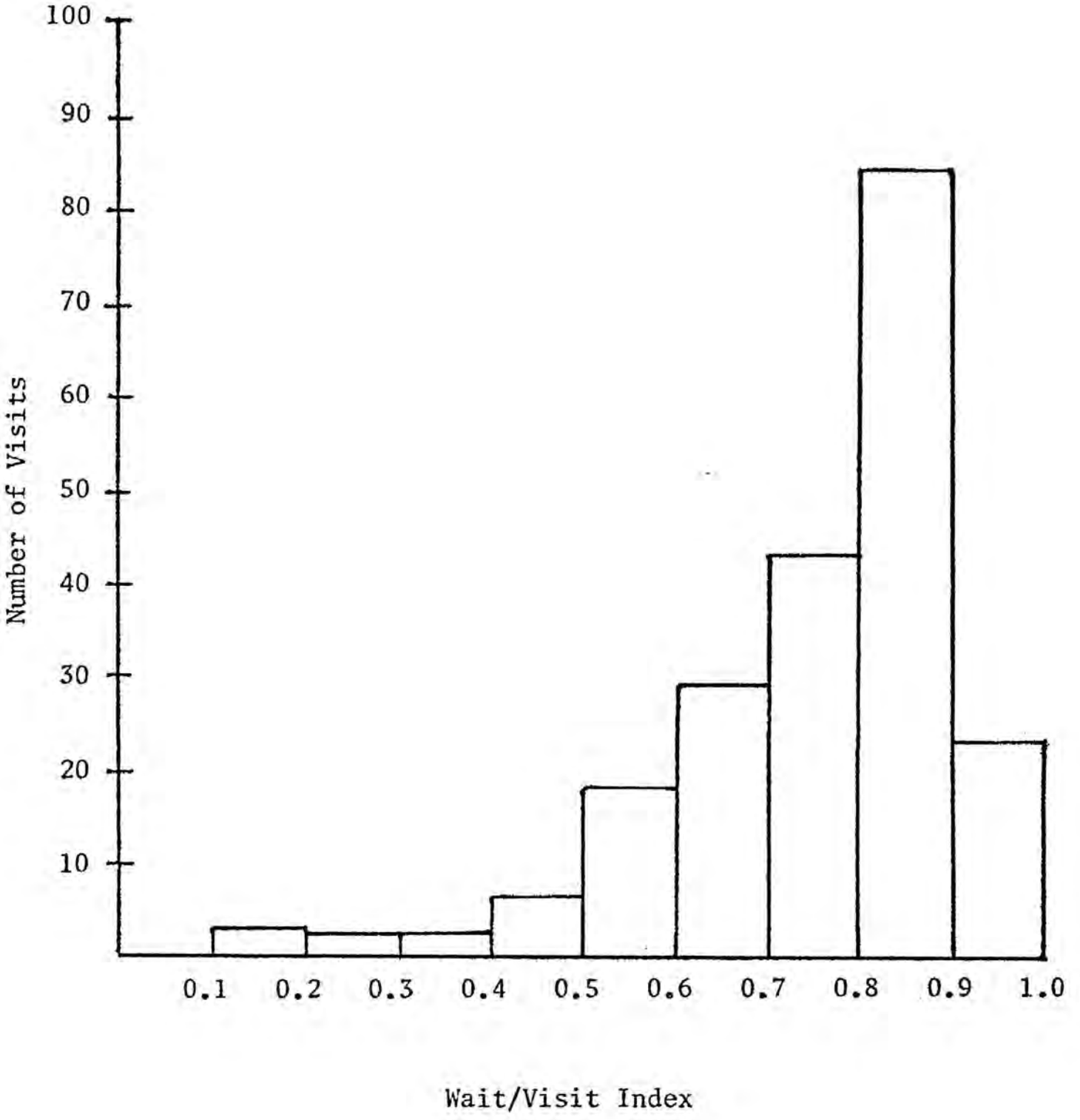


Figure 4.9
Distribution of Wait/Visit Indices



LABORATORIES

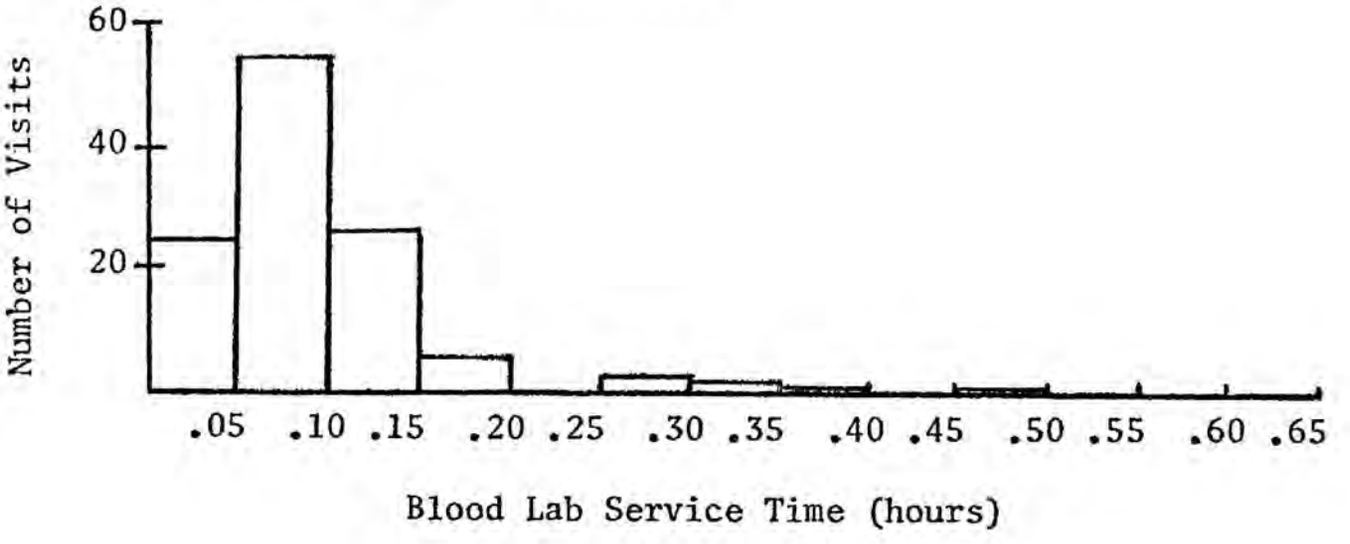
The frequency distributions of the service times for the blood laboratory, EKG and x-ray labs are displayed in Figure 4.10.

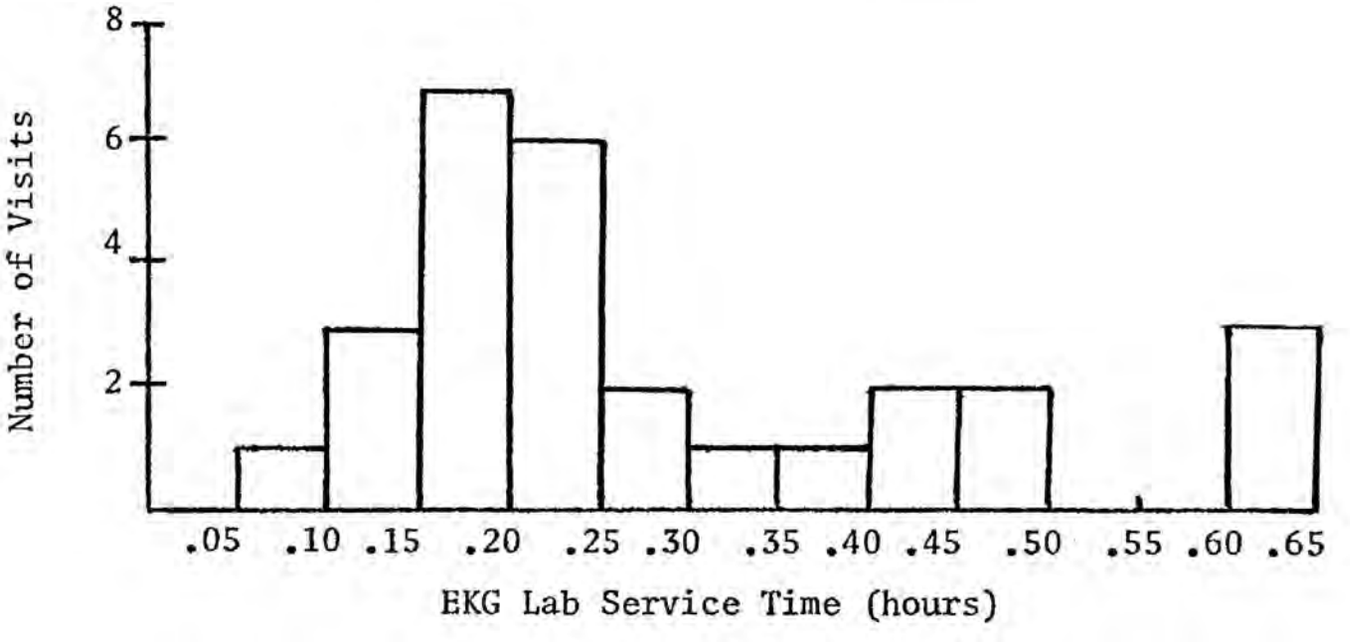
Visits to the blood laboratory to have blood drawn for testing were recorded for 121 patients. The average time to travel and queue for service at the laboratory was 0.20 hour (12.0 minutes). The mean service time in the blood lab was 0.09 hour (5.4 minutes).

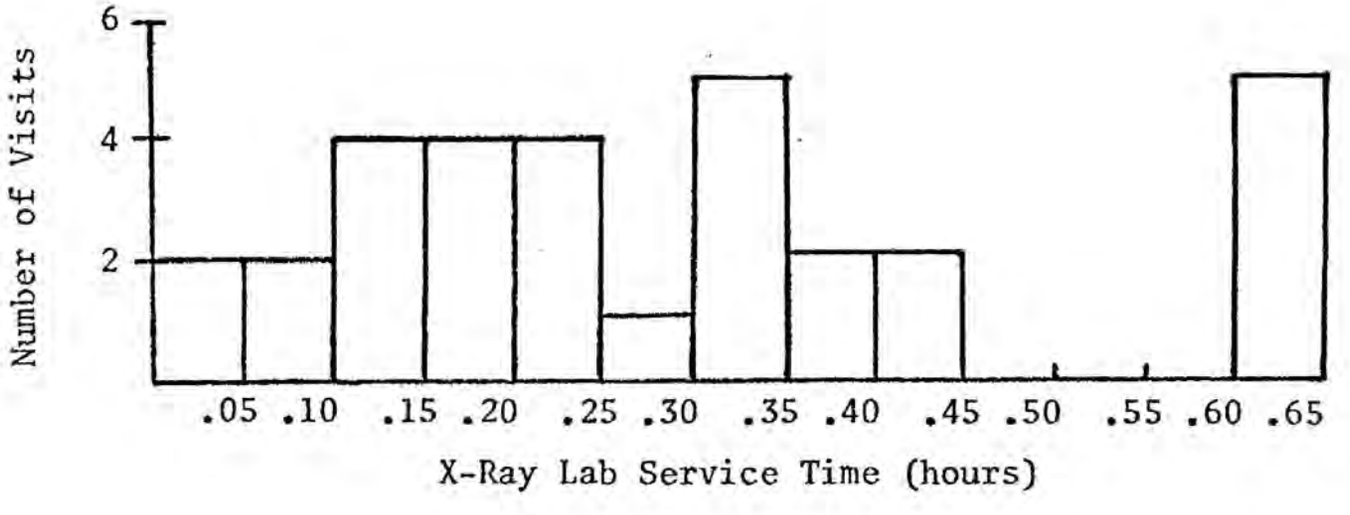
The mean travel time for the twenty-eight patients who required an EKG was 0.50 hour (30.0 minutes). The average service time was 0.28 hour (16.8 minutes).

Thirty-one patients had visits recorded at the x-ray laboratory. The mean travel time was 0.37 hour (22.2 minutes) and the service time in x-ray averaged 0.39 hour (23.4 minutes).

Figure 4.10
Distributions of Service Times
for Laboratories







Correlation with Demographic Characteristics

A correlation analysis was performed to determine if any of the demographic characteristics of the population served had an influence on the rate of patient flow through the clinic. As seen previously, patient flow officially began when the nurses called the patients for registration. In a discussion with members of the clinic staff, it was learned that patients usually were registered in order of arrival at the clinic unless the nurse felt that the patient was very ill or had travelled a long distance. Thus, before the analysis was performed, a correlation was suspected between certain demographic characteristics and selected measurements of patient flow.

The results of the correlation analysis are summarized in Figure 4.11. The patient flow variables included arrival times at general registration and General Medicine registration, clinic exit time, total visit time and the wait/visit index. The demographic variables consisted of patient's age, number of children, number of people in the household, education (as measured by the last school grade completed) and distance travelled to attend the clinic.

The patient arrival times at general registration were correlated with the arrival times at General Medicine Clinic. Also, the arrival times at General Medicine registration correlated with the exit times from the clinic. Neither of the arrival times or the exit times correlated with the visit length or the wait/visit index.

The correlation analysis of the selected patient flow variables with the demographic characteristics revealed that the only demographic variable correlated with general registration was the distance travelled by a patient

Figure 4.11

Correlation of Patient Flow Variables

with Selected Demographic Characteristics

	Age	Distance travelled	Number of people in household	Number of children	Education	General reg. arrival	General Medicine reg. arrival	Exit time	Visit length	Wait/visit index
Age			** .30	* .09	** .49		** .16			
Distance travelled				** .13		* .13				
Number of people in household				** .33						
Number of children										
Education							* .12			
General reg. arrival							** .54	** .34		
General Medicine reg. arrival								** .57		
Exit time										
Visit length										
Wait/visit index										

* = significant at 0.05 level

** = significant at 0.01 level

to attend the clinic. Arrival at General Medicine registration correlated with both patient age and education. None of the demographic characteristics correlated with exit time, length of visit or the wait/visit index.

Discussion

The value of a patient flow analysis lies in the discovery of inhibitors to smooth patient flow through the examination of the distributions of the service and queue times. In the General Medicine Clinic the mean service times for the activities registration, height-weight-temperature, physician examination and appointment/exit were reasonable. In comparison with other clinics [13,14], the mean visit time was not exceptional. The overall clinic wait time, however, was quite high, with most of this time occurring after height-weight-temperature and before examination. While some waiting is recognized as being inevitable, reducing the amount to more acceptable levels seems warranted, especially in the interest of patient satisfaction.

Results from the patient flow study implicate the block appointment system as the primary source of patient waiting time in the General Medicine Clinic. Johnson and Rosenfeld [12] have stated, "The conventional block system has certain inherent attributes that contribute to waiting time and congestion." The two authors write elsewhere [13] that a block appointment type clinic is characterized by waves of patient arrivals in the early part of the session. Also, the doctor session typically begins later, thereby forcing all patients who arrived at the appointed time to wait until the first doctor begins examination.

The problems associated with the block appointment system of overwhelming patient arrivals, excessive waiting times and patient congestion are evident in the General Medicine Clinic studied. Figure 4.1 clearly

shows the effects of the block appointment system on the patient arrival patterns with a large wave of patients arriving at registration/height-weight-temperature from 12:30 p.m. to 1:30 p.m.. Patient arrivals at examination did not steadily increase to a peak, but started at a maximum since all patients to be seen that day were already in the clinic system.

Although the block of patients was processed through registration and height-weight-temperature rather quickly, the flow of patients encountered a "bottleneck" at examination. The late arrival of the doctors, the small number of physicians present relative to the number of patients requiring attention, and the actual amount of time needed for the physician examination all constricted the flow through examination. It was at this point of the clinic visit and for the reasons given above that most of the excessive waiting time was generated.

As stated previously, congestion is an inherent feature of the block appointment system since all the patients scheduled for the day are in the clinic at the same time. Human congestion in the General Medicine Clinic passageways and waiting rooms was observed by the evaluation team during the sample period. The situation caused by the block appointment was further aggrevated by certain characteristics of the population being served. As seen in Chapter III, most of the patients had to rely on friends, relatives or public transportation to bring them to the clinic. Often the friend or relative who brought a patient was also staying for the duration of the visit, adding to the congestion. In addition, many of the patients relying on public transportation remained inside the clinic after their visit was over, waiting for taxis or buses and again adding to the congestion.

Without changing the block appointment system, some of the problems caused by the system could possibly be improved by requiring the house staff to arrive at 12:30 p.m.. This would not affect the rate of arrivals at registration and height-weight-temperature but would result in a more uniform distribution of patient arrivals at examination and appointment/exit over the afternoon. Hopefully, waiting times for most, if not all of the patients would be improved. By far the best solution would be the use of an individual appointment system. This in itself may cause problems of a different nature. For example, the best time interval between appointments would have to be determined, the effect of patient punctuality on the system must be considered, and whether or not one system could operate for both new and old patients would have to be evaluated. Nevertheless, an individual appointment system would certainly eliminate the wave of patients seen at the clinic's opening, and allow a more uniform distribution of arrivals at each of the clinic stations. Both the lengthy waiting times and the congestion should be reduced under an individual appointment system.

The correlations existing among the selected patient flow variables were not unusual for a clinic in which patients are serviced in order of their arrival. The correlations between distance travelled and general registration arrival time, between age and arrival time at General Medicine registration, and between education and arrival time at General Medicine registration show some evidence of a linear relationship between the variables. However, these correlation coefficients obtained from the data are not large enough for predictive purposes or formulating recommendations.

The most interesting information to come from this correlation analysis was the lack of a linear relationship between the demographic characteristics and the patient flow variables exit time, clinic visit time and the wait/visit index. Thus in the General Medicine Clinic the demographic characteristics of the population served did not appear to influence the rate of patient flow in the clinic, the length of clinic stay or the amount of waiting a patient experienced. For purposes of simulation and planning, therefore, the effect of the demographic characteristics on these aspects of patient flow may be ignored.

Chapter V

THE WORK SAMPLING ANALYSIS

Distribution of Staff Work Effort

Over the sampling period 3,815 observations of the General Medicine Clinic staff were recorded. Table 5.1 presents the distribution of observations by staff over the four activity groupings. The number of observations is also expressed as a percentage of the total number of observations.

The work load for each staff level appeared to be distributed among the activity groupings as one would expect for that level. The house staff spent 79% of their clinic time in patient care activities. Licensed practical nurses also devoted a major portion of their time to patient care. The registered nurses' productive time was divided almost equally between patient care and administrative duties. Nonproductive time, however, appeared to be too high for the RN's, LPN's and clerks. According to the sample, nonproductive activities accounted for between 41% and 47% of the time recorded for these three staff levels.

In Table 5.2 the nonproductive activities were broken down into the actual listings recorded for the RN's, LPN's and clerks. It is interesting to note that it was not the "out of clinic" listings which constituted most of the nonproductive observations. On the contrary, it was the "on duty, idle" listing which accounted for between 60% and 80% of the nonproductive activities recorded for the RN's, LPN's and clerks. Much

Table 5.1

Activity Profile Summary

	House Staff		RN		LPN		Clerk		Combined Staff	
	no.	%	no.	%	no.	%	no.	%	no.	%
Patient Care	1375	78.66	233	27.03	373	45.10	19	5.03	2000	52.42
Consulting	44	2.52	14	1.62	14	1.69	2	0.53	74	1.94
Administrative	58	3.32	264	30.63	55	6.65	178	47.09	555	14.55
Nonproductive	271	15.50	351	40.72	385	46.55	179	47.35	1186	31.09
Total	1748	100.0	862	100.0	827	100.0	378	100.0	3815	100.0

Table 5.2

Distribution of Observations

of Nonproductive Activities for RN's, LPN's and Clerks

	RN		LPN		Clerk	
	no.	%	no.	%	no.	%
Activity						
Waiting for facilities	0	0.00	0	0.00	1	0.56
Out of clinic/Location unknown	69	19.66	24	6.23	21	11.73
On duty, idle	213	60.68	315	81.82	118	65.92
Out of clinic/Attending meeting	0	0.00	1	0.26	0	0.00
Out of clinic/in other clinic	22	6.27	7	1.81	9	5.03
Out of clinic/lunch	5	1.42	5	1.30	4	2.23
Out of clinic/sick	0	0.00	3	0.78	0	0.00
Out of clinic/On break	18	5.13	15	3.90	8	4.47
Out of clinic/Gone for day	24	6.84	15	3.90	18	10.06
Total	351	100.00	385	100.00	179	100.00

of the "on duty, idle" time can be attributed to the inevitable waiting for patients to complete one phase of their clinic visit and begin another.

Activity Analysis Profile

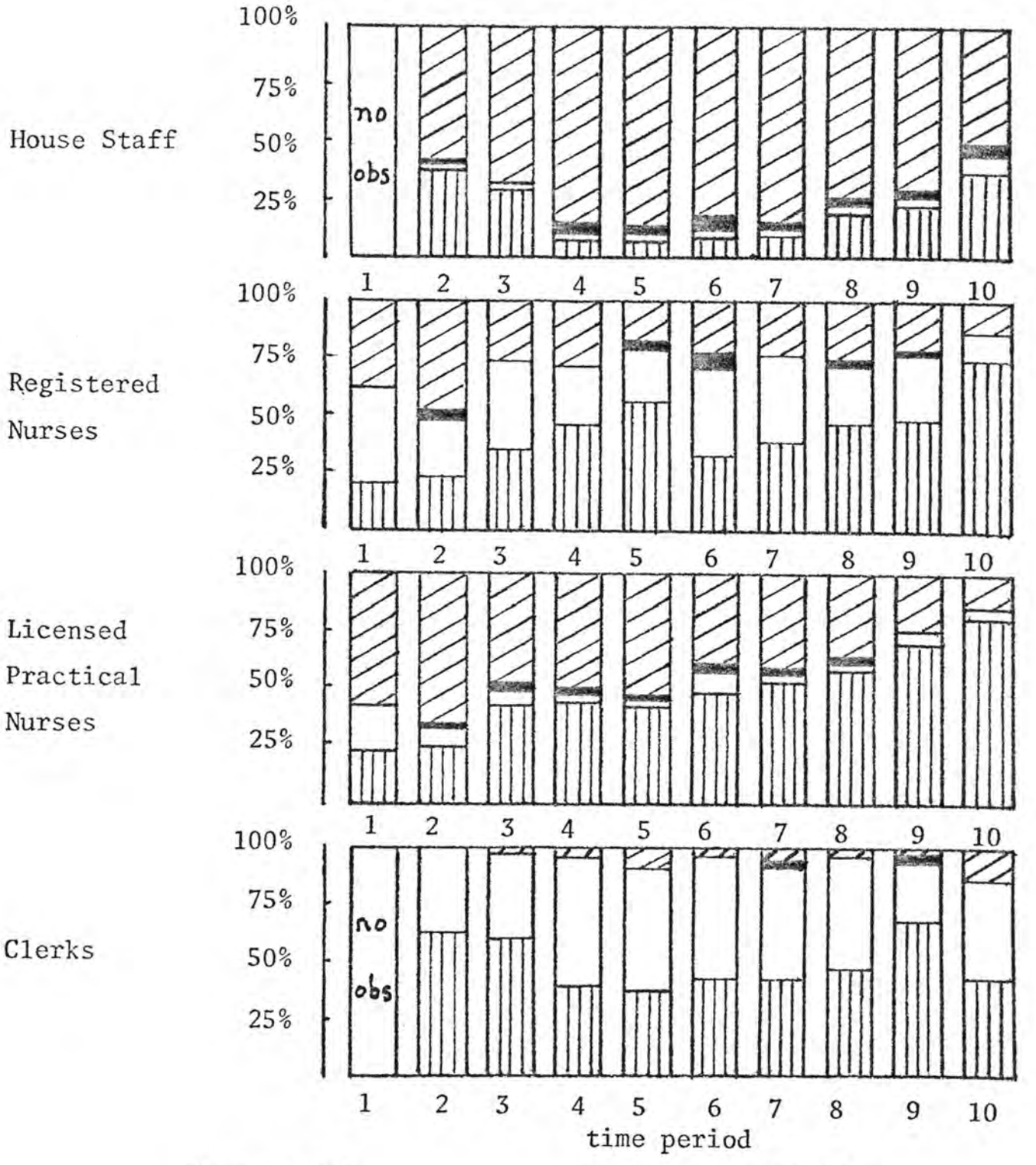
Figure 5.1 is an Activity Analysis profile. It presents for each staff level and for any given half-hour interval the percentage allocation of work distributed among the four activity groups on an average clinic day. For example, from 2:00 p.m. to 2:30 p.m. on an average day, the house staff spent about 87% of their time in patient care, 3% in consulting, 3% in administrative duties and about 7% of their time in non-productive activities. Percentages were not given for the first half-hour interval for the house staff and clerks since they did not begin their General Medicine Clinic duties until 1:00 p.m..

In Figure 5.1 there was a quick build-up of patient care activities, which consumed the major portion of the house staff's time during the clinic day. The proportion of this activity did not diminish until around 4:00 p.m., when the last of the patients for that day were examined. Administrative duties consumed very little of the house staff's time. The proportion of nonproductive activities was quite low, particularly during the busy middle portion of the clinic session.

The profile for the registered nurses shows that, as the clinic day progressed, the proportion of nonproductive activity increased, not only for the RN's, but for the other levels of staff as well. The interesting feature of the RN's activity profile is the relative amounts of time spent in patient care and administrative duties. A substantial amount of administrative work was expected since the registered nurses were in charge of the actual day to day operation of the clinic. Yet, for most

Figure 5.1

Activity Analysis Profile



time period

1 = 12:30 - 1:00
2 = 1:00 - 1:30
3 = 1:30 - 2:00
4 = 2:00 - 2:30
5 = 2:30 - 3:00
6 = 3:00 - 3:30
7 = 3:30 - 4:00
8 = 4:00 - 4:30
9 = 4:30 - 5:00
10 = 5:00 - 5:30

activity

= patient care
= consulting
= administrative
= nonproductive

of the clinic day, the percentage of work expended in administrative duties equalled or exceeded that for the patient care duties.

A large proportion of the licensed practical nurses' time was spent in patient care activities. Except for the first hour of the clinic when they were involved in patient registration, the distribution of patient care activities for the LPN's closely follows the patient care distribution for the house staff. This can be explained by noting that the LPN's assisted the house staff in the examination portion of a patient's clinic visit. However, the proportion of time consumed by non-productive activities was substantial, increasing from 1:30 p.m. until the close of clinic.

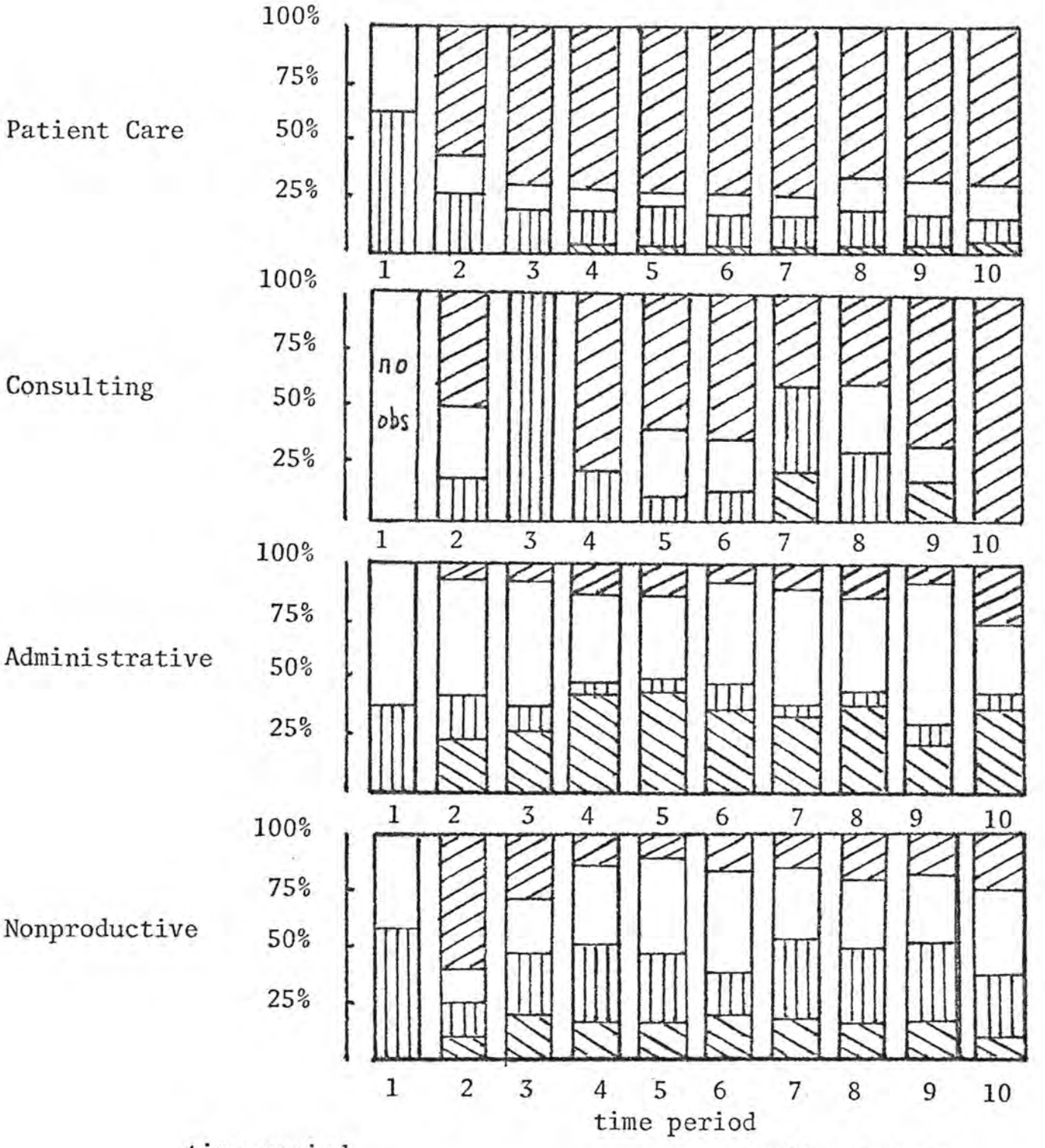
As expected, the clerks were involved primarily in administrative duties. Most of these duties occurred later in the clinic day as patients finished their examinations and then made appointments with the clerks for laboratory work or return visits. Again, as for the RN's and the LPN's, the proportion of time spent in nonproductive activities was very high over the clinic session.

Relative Effort Profile

The Relative Effort profile, presented in Figure 5.2, displays for each activity grouping and for any given half-hour interval the percentage allocation of work effort distributed among the four levels of staff on an average clinic day. From 1:00 p.m. to 1:30 p.m. on an average day, house staff were responsible for approximately 8% of the administrative work that was done during the half-hour, while RN's accounted for about 58%, LPN's accounted for 23%, and clerks were responsible for about 11% of that half-hour's administrative work.

Figure 5.2

Relative Effort Profile



time period

1 = 12:30 - 1:00
2 = 1:00 - 1:30
3 = 1:30 - 2:00
4 = 2:00 - 2:30
5 = 2:30 - 3:00
6 = 3:00 - 3:30
7 = 3:30 - 4:00
8 = 4:00 - 4:30
9 = 4:30 - 5:00
10 = 5:00 - 5:30

staff category

= House staff
= RN
= LPN
= Clerk

As seen in Figure 5.2, most of the patient care in the General Medicine Clinic was delivered by the house staff. With the exception of the first half-hour before the house staff had arrived, the LPN's percentage of work effort in patient care activities is consistently higher than that for the registered nurses.

Considering that the General Medicine Clinic is a teaching clinic with a goal of providing learning experiences for all levels of staff, the consulting profile shows that a good mixture of staff interaction was occurring.

The administrative duties of the clinic were shared primarily by the registered nurses and the clerks. Again, the clerks did not arrive until 1:00 p.m. and patient registration, which started at 12:30 p.m., was the responsibility of the RN's and the LPN's. This profile, as the RN's profile in Figure 5.1, confirms the registered nurses' involvement in the operation of the clinic.

The majority of the day's nonproductive activities was divided between the RN's and the LPN's. Considering those half-hour intervals in which observations were recorded for all four staff levels, most of the nonproductive time for the LPN's and RN's occurred later in the afternoon, after patient registration was completed and while examinations and scheduling of appointments were going on.

In general, the distribution of work effort among the four staff levels within each activity grouping remained fairly constant after 1:30 p.m.. Although, as Figure 5.1 shows, the staff directed its attention to different types of activity from half-hour to half-hour, Figure 5.2 tells us that the proportion of work accomplished by each level in a particular activity grouping remained fairly well defined over the clinic

day.

Correlation of Work Sampling and Patient Flow Variables

As seen in Chapter IV, the results from a patient flow analysis are of significant value in finding "bottle-neck" areas in the clinic, usually characterized by a line of patients each of whom must experience a long waiting time before receiving service. In turn, the work sampling analysis is of benefit in determining how and in what activities the work effort of the clinic staff is distributed.

Additional insight into clinic operation can be gained from analysis of the data from both the work sampling and patient flow studies. As an example of this, Mamlin and Baker [13] have noted the usefulness of combining the two studies to further investigate the average examination of a doctor. In their study, Mamlin and Baker subdivided the physician time per patient, as found by the patient flow study, into its component parts using the work sampling observations on those same physicians.

In the present study, a correlation analysis was performed to examine the relationship between the rate of patient flow through the clinic and the work effort of the clinic staff. Figure 5.3 summarizes the results of the correlation analysis. Work effort variables include the average number of personnel present for each staff level and the number of work sampling observations recorded in each activity group for the different staff levels. Observations for the work effort variables were taken over the ten half-hour intervals for the average clinic day. The patient flow variables include the number of people awaiting service, or being served, at various points in the clinic during the average day. This number has been computed from patient flow data at the mid-point of the

Figure 5.3

Correlation Analysis

of Work Sampling and Patient Flow Variables

		await reg	in reg	in HWT	await exam	in exam	await doc.	in A/E
House Staff -	Patient Care					.84**	.69*	.78*
	Consulting							
	Administrative							
	Nonproductive	.95**	.92**	.91**				
	$\bar{n}$					.91**	.78*	.75*
Registered Nurses -	Patient Care						.65*	
	Consulting							
	Administrative							.64*
	Nonproductive	-.84**	-.77**	-.80**				
	$\bar{n}$							
Lic. Practical Nurses -	Patient Care				.81**	.84**	.91**	
	Consulting							.81**
	Administrative	.77**	.78**	.80**				
	Nonproductive	-.76*	-.69*	-.72*				
	$\bar{n}$							
Clerks -	Patient Care							
	Consulting							
	Administrative							.84**
	Nonproductive							
	$\bar{n}$					.87**	.77*	

* = significant at 0.05 level

** = significant at 0.01 level

half-hour interval and is assumed to be an accurate representation of the patient flow situation over the half-hour period.

In Figure 5.3, the number of patients being registered and serviced at height-weight-temperature was highly correlated with the house staff's and registered nurses' nonproductive activities and the administrative work of the licensed practical nurses. A correlation also existed between these patient flow variables and the LPN's nonproductive activities. Thus, it can be seen that at the beginning of the clinic session when patients were being registered and serviced at height-weight-temperature, the RN's and LPN's were engaged in productive work and, more specifically, the administrative duties of the LPN's were increased. The house staff, however, showed an increase in nonproductive activities at this time. This confirms the fact that the house staff had usually not reported to the General Medicine Clinic until most of the patients had completed registration/height-weight-temperature. Therefore, during the early part of the clinic session, the work sampling observers recorded the house staff as being "out of clinic", a listing which falls into the nonproductive grouping.

The number of patients queuing for examination was correlated with the patient care activities of the licensed practical nurses. A significant correlation existed between the number of patients awaiting physician examination and the patient care activities of the house staff, the registered nurses and the licensed practical nurses. The number of house staff and clerks present in the clinic also correlated significantly with the number of patients awaiting physician examination. The patient care activities of the house staff and LPN's and the number of house staff and clerks present were highly correlated with the number of

patients in physician examination.

Thus as the patients finished registration/height-weight-temperature and began queuing for examination, the LPN's patient care activities increased. Later, as the number of patients going through examination increased, the house staff, LPN's and RN's all experienced an increase in patient care duties. Since the majority of the house staff and clerks arrived in the clinic the same time the patients were queuing for and beginning to be examined, a strong positive correlation existed between the number of house staff and clerks present and the number of patients waiting for and being served at physician examination.

The number of patients making appointments and scheduling lab work was correlated with the patient care activities of the house staff, the number of house staff present in the clinic, the administrative duties of the clerks and the registered nurses, and the consulting activities of the licensed practical nurses.

By the time patients began making appointments and exiting the clinic in large numbers, clinic operation was at a peak. The house staff was occupied with patient care activities, examining patients who then proceeded to appointment/exit. As the number of patients making appointments increased, the clerks had an expected increase in administrative work. Part of this administrative work of making appointments and scheduling lab work was also done by the registered nurses, as evidenced by the correlation analysis and observed in the clinic by the evaluation team. During this very active part of the clinic session, the LPN's had an increase in consulting activities, as they assisted the physician in patient examination. Later in the afternoon as the doctors finished their examination and departed, the number of patients making appointments

decreased.

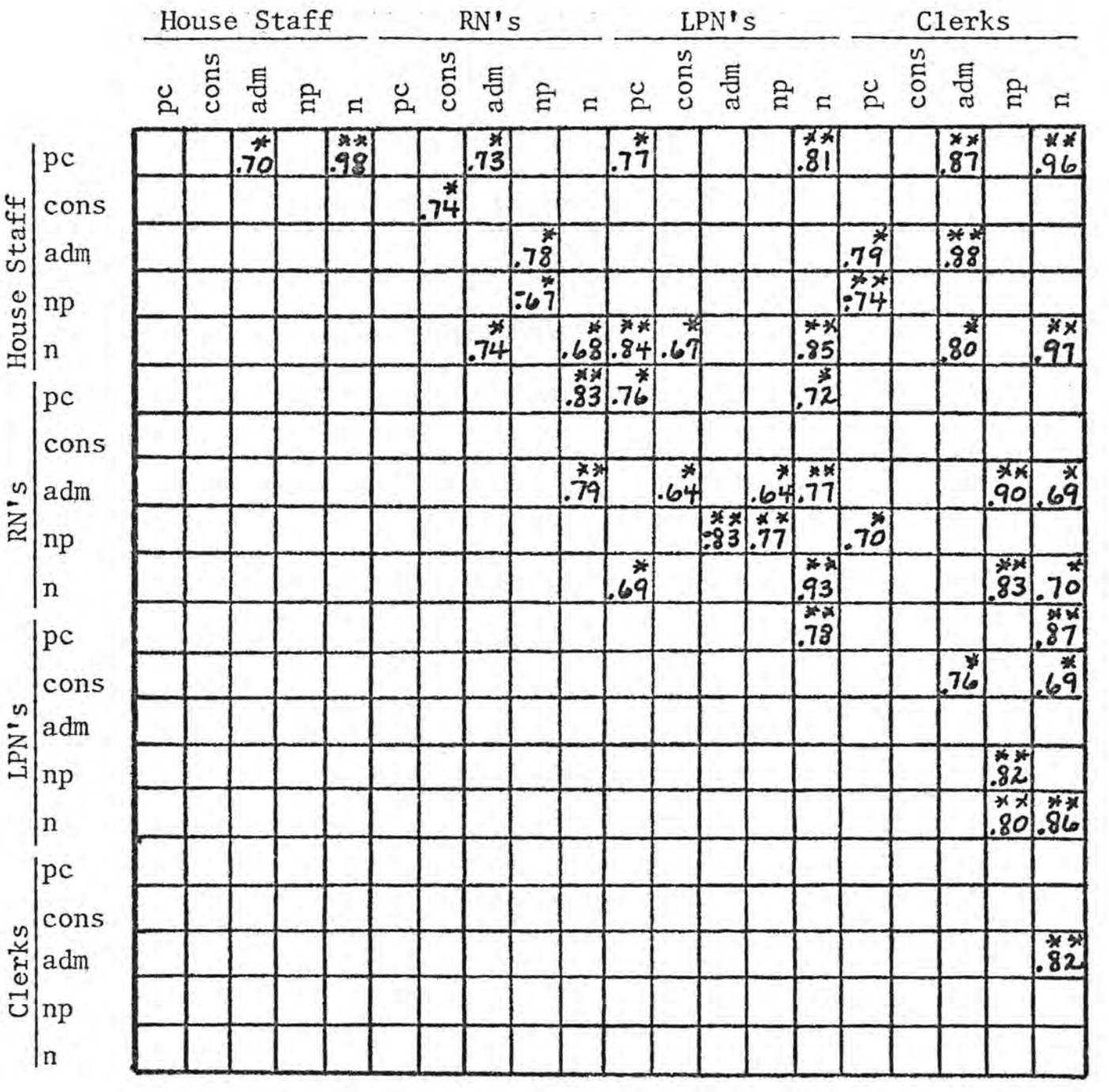
Correlation Among the Work Sampling Variables

A more detailed examination of the interaction and competition between staff activities emerges from the results of a correlation analysis of the work sampling variables, presented in Figure 5.4. Work effort variables consist of the average number of personnel present for each staff level and the number of work sampling observations recorded in each activity group for the different staff levels. Observations for the work effort variables were taken over the ten half-hour intervals for the average clinic day.

The correlation analysis corroborates the findings of the activity analysis profile, the relative effort profile and the correlation analysis of work sampling and patient flow variables. As the number of physicians in the clinic increased, the patient care activities of both the house staff and the licensed practical nurses rose. In addition, an increase in the house staff's patient care activities permitted the registered nurses and clerks to turn their attention to administrative affairs. The work effort of the registered nurses was closely connected to that of the licensed practical nurses. The RN's and LPN's appeared to work together in patient care activities, and both were nonproductive at the same time. An increase in administrative duties for the LPN's saw a reduction in the nonproductive work of the RN's. Finally, the non-productive time of the clerks and the RN's appeared to be associated, and may be an indication of common break time. As noted previously, as the RN's assumed administrative duties, the clerks' nonproductive time increased.

Figure 5.4

Correlation Analysis of Work Sampling Variables



* = significant at 0.05 level
** = significant at 0.01 level

LEGEND: pc: patient care
cons: consulting
adm: administrative
np: nonproductive
n: average number of staff present

Discussion

Overall, the distribution of productive activities among the levels of clinic staff was as one would expect, with the house staff delivering most of the clinic's patient care and the clerks involved primarily with administrative affairs. However, a sobering feature brought out by the analyses was the relative amounts of patient care performed by the registered nurses and the licensed practical nurses. The fact emerged that the licensed practical nurses delivered more patient care than the highly trained registered nurses. Admittedly, the registered nurses had to perform administrative duties in connection with their role of supervising the day-to-day operation of the clinic. Nevertheless, the registered nurses were spending relatively little of their clinic time on the tasks for which they were professionally and educationally prepared.

In Chapter IV, the problem of overwhelming patient arrivals associated with the block appointment system was discussed with regard to the constricting flow of patients through the various stations. From the work sampling analyses the situations caused by the block appointment system and the late arrival of the house staff and clerks can be discussed from the viewpoint of the clinic staff, rather than the patients.

First of all, the late arrival of the house staff assures at the expense of patient waiting time that the patient care abilities of the house staff are fully utilized. This can be clearly seen in the activity analysis profile for the house staff. After a late arrival, only a small proportion of the house staff's time was devoted to activities other than patient care. In addition, the late arrival of the clerks guaranteed to a lesser extent that they would be involved only in making appointments

and scheduling lab work. Thus, if the only duty of the clerk is to schedule appointments and lab work, there would be no need for the clerks to arrive earlier in the session. If the clerks are capable of chart work, however, it is possible that they could assume this portion of the registered nurses' administrative work, particularly during registration/height-weight-temperature. It is realized that, in the clinic studied, clerks arrived only after their work in a morning clinic was completed. Yet, it is interesting to speculate on the effect that the clerks' presence at clinic opening would have on the workload on the registered nurses. The presence of the clerks could possibly free the registered nurses for more patient care, or adversely, more nonproductive time for the registered nurses may result.

The amount of nonproductive activities for the RN's, LPN's and clerks was excessive. What is particularly disturbing is that this nonproductive time was composed largely of "on duty, idle" time. Excessive nonproductive time may be caused by overstaffing, but that is not believed to be the case here, as observed by the evaluation team. Instead, this excess nonproductive time seemed to be a direct result of the block appointment system.

The block appointment system appeared to produce waves of work for different levels of staff at certain periods of the clinic session. As an example, it can be seen from the correlation analysis of the work sampling and patient flow variables that the registered nurses and licensed practical nurses were very busy with registration and height-weight-temperature during the early part of the clinic session. Yet, from the activity analysis profile, the nonproductive time for the RN's and LPN's then steadily increased over the afternoon. Thus, as different

services closed down, various staff members were forced to turn their attention to other work, or sit idle. Therefore, a desirable appointment system would produce a more even distribution of activities for each level over the entire clinic session, rather than spurts of excessive activity followed by long periods of inactivity.

Chapter VI

SUMMARY AND CONCLUSIONS

A study was begun in early 1974 at the Medical University of South Carolina (MUSC) to obtain measurements through patient flow and work sampling analyses of how efficiently the MUSC Outpatients Departments were delivering health care. It was anticipated that the patient flow analysis would reveal areas in a clinic's operation causing undue, excessive waiting time for its patients. Results from the work sampling analysis would hopefully explain the clinic staff's role in patient flow problems and also reveal the interactions among the work effort of the staff. In conjunction with these two analyses, a demographic study was conducted to determine the influence, if any, of the characteristics of the population served on the rate of patient flow through the clinic. This paper reports the results of the patient flow, work sampling and demographic analyses of one of the MUSC's Outpatients departments, the General Medicine Clinic.

The rationale of a clinic effiency study was discussed in Chapter I. Results of previous work in the area were cited from the literature. The specific objectives of the analyses as pertaining to the MUSC General Medicine Clinic were outlined.

A description of the General Medicine Clinic and its operation was presented in Chapter II. The methods and mechanics used in data collection of the three analyses were outlined. Management of the raw data was

discussed, and the information system employed to generate the summary statistics was described.

Results of the demographic study were described in Chapter III. Variables in the analysis included sex, age, educational level, number of people in household, number of children, residence, distance travelled to clinic, mode of travel and transportation costs. Patient counts by visit type, method of payment and source of referral were also obtained. The daily patient loads and the frequency distributions of patient arrival times at general registration and General Medicine registration were displayed. Approximately eighty-two percent of the sample had arrived at the clinic and completed preliminary registration by 12:00 noon, although the General Medicine Clinic did not open until 12:30 p.m.. Crowded facilities and additional patient waiting time resulted.

The patient flow analysis was the topic of Chapter IV. Patient arrival patterns and the mean queue and service times for the various clinic activities were presented. Frequency distributions of the queue and service times for the activities were displayed and discussed. Also included were frequency distributions of the travel and service times of the laboratory visits, the clinic visit times, the total waiting times, and the wait/visit indices. Service times for the various clinic activities were reasonable and the mean visit time was not exceptional. The overall clinic wait time was found to be high, and reducing the amount of waiting to more acceptable levels were recommended, particularly in the interest of patient satisfaction. The possible influence of the demographic characteristics of the population on the patient flow was investigated through a correlation analysis. Results of the analysis revealed evidence of a linear relationship between distance travelled

and arrival time at general registration, between age and arrival time at General Medicine registration and between educational level and arrival time at General Medicine registration. These correlation coefficients obtained from the data, however, are not large enough for predictive purposes or formulating recommendations. The demographic characteristics of the population did not appear to influence the rate of patient flow in the clinic, the length of clinic stay or the amount of waiting a patient experienced. Thus for purposes of simulation and planning, the effect of the demographic characteristics on these aspects of patient flow may be ignored. The chapter concluded with a discussion of the results of the patient flow analysis.

Chapter V examined the work sampling analysis. The clinic staff's work effort was displayed and discussed through means of an activity analysis profile and a relative effort profile. The distribution of productive activities among the levels of clinic staff was as one would have expected. However, the proportion of time spent by the registered nurses, licensed practical nurses and clerks in nonproductive activities was very high, with most of this time consisting of idle time. A correlation analysis was performed to investigate the relationship between staff workload and patient flow. Strong correlations were found to exist among the number of patients queuing for or receiving service and various levels of work effort of the staff members involved in that service. The correlation among the staff's clinic activities was also examined. The patient care duties of the house staff were directly correlated with the patient care activities of the LPN's and the administrative work of the RN's and clerks. The work effort of the RN's was closely connected to that of the licensed practical nurses. In addition, the nonproductive

time of the clerks and the registered nurses appeared to be associated. A discussion of the results from the work sampling analysis concluded the chapter.

The problems in the General Medicine Clinic associated with patient flow and staff work effort have been discussed at length in the chapters in which they were revealed. Many of these problems arose as a result of the use of a block appointment system to schedule patient visits. As remarked previously in the discussions of Chapters IV and V, the employment of an individual appointment system was recommended as a possible solution to improve patient waiting times and reduce the amount of non-productive activities done by the staff.

In the summer of 1975 the General Medicine Clinic moved from its old quarters to a new setting, the MUSC Clinical Sciences Building. At this time certain operational changes were implemented, which included extending the clinic hours from afternoon to full day sessions and changing from the block appointment system to an individual appointment system. A re-evaluation of the clinic to determine the effects of the changes on the patients' waiting and service times would be invaluable. A previous study, mentioned by Fetter and Thompson [8] and conducted by the Yale Program in Hospital Administration and the Department of Industrial Administration, explored the problem of whether waiting and service times in a municipal hospital would be affected by a change in physical location. The study revealed that there were no changes in patients' waiting or service times. Therefore, assuming that a change in location would not influence patients' waiting and service times, a re-evaluation of the General Medicine Clinic could determine the effects of the administrative changes. In addition, a re-evaluation of the clinic would test the

validity of the efficiency analysis in reviewing and formulating recommendation.

The analyses presented in this paper afford health care providers simple, yet effective, techniques for measuring the efficiency of a facility's operation. Patient flow measurements are recorded over time, yielding not only the usual total time variables, but also giving valuable information on when and how long events are occurring within a patients' visit. Observations are simultaneously recorded on staff activities. From these observations, a breakdown of work effort and, more importantly, a view of the interplay between the patients' demands and the staff's services are obtained. Thus, by placing the results of the analyses in the time frame of an average daily session, the variability of the patient flow and staff activities can be readily observed.

Data from the analyses are vital to the process of modelling the clinic for future simulation studies. Parameters for the model are obtained from the data, and the uses of the computer model can be validated by comparisons with the results of the studies. With a model which accurately represents the system, the clinic can be tested as though operating under various alternate conditions, such as an increase or decrease in the number of staff, a change in the type of appointment system used, or varying the amounts of patient-physician encounter time.

LIST OF REFERENCES

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